

AtkinsRéalis



# Stage 2 Structural Assessment Report

Mayo County Council

February 2025

# N5 KNOCKAVRONY BRIDGE REHABILITATION WORKS



Comhairle Contae Mhaigh Eo  
Mayo County Council

# Notice

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## Document history

Document title: MO-N05-013.00 Knockavrony Bridge Stage 2 Assessment

Document reference: 0088572DG0017

Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
0.0	Draft for Comment	VP	MG	MJ	MJ	18/11/2024
1.0	Issue for Review	VP	MG	MJ	MJ	07/02/2025

## Client signoff

<b>Client</b>	Mayo County Council
<b>Project</b>	TASK ORDER NO.315 MAYO BRIDGE ASSESSMENTS AND STRENGTHENING 2023
<b>Job number</b>	0088572
<b>Client signature/date</b>	



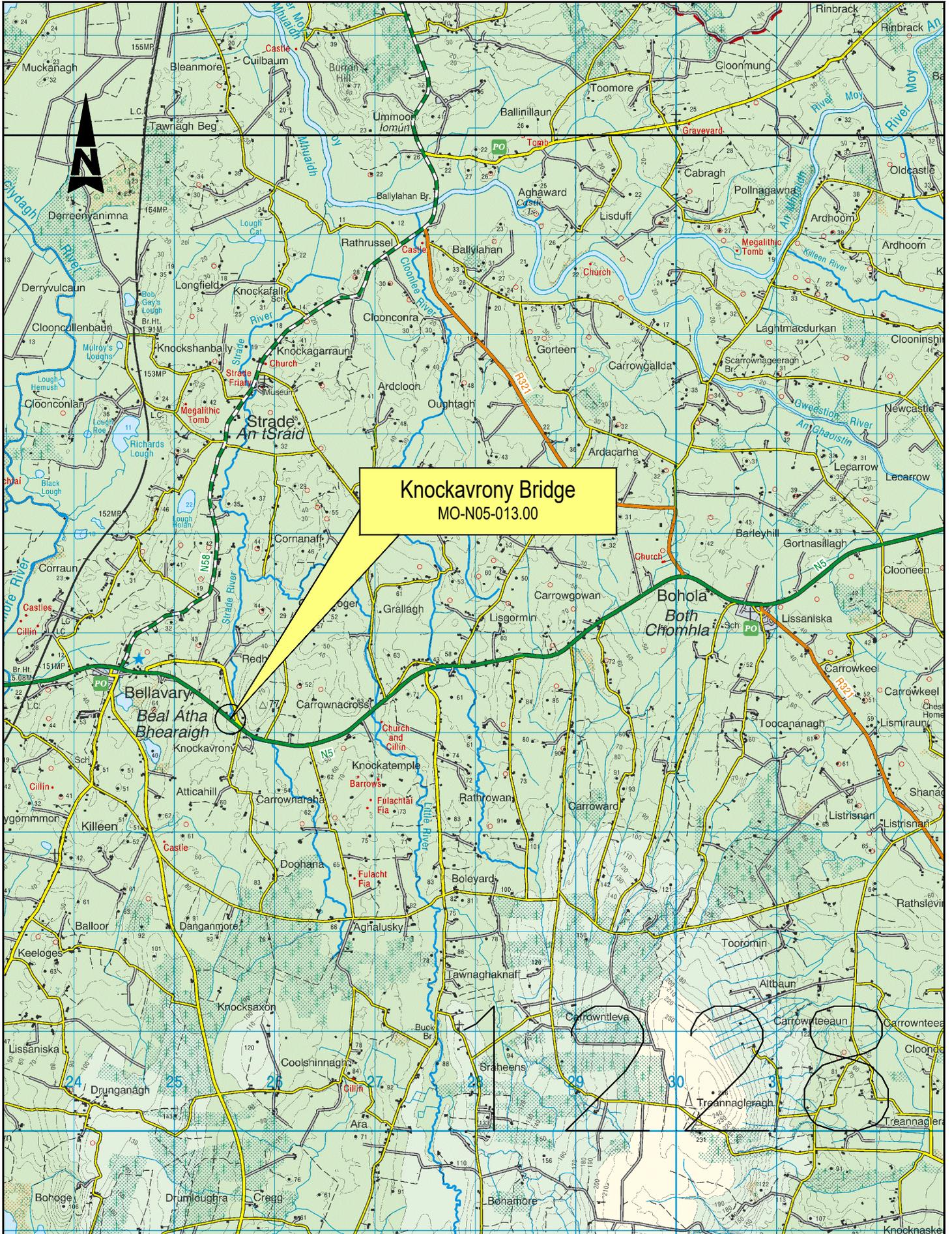
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**Task Order No.315- Mayo Bridge Assessments**



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# 1. Introduction

AtkinsRéalis were appointed by Mayo County Council for Eirspan Task Order 315 – Mayo Bridge Assessments and Strengthening 2023, comprising the assessment and rehabilitation of 10no. bridges on the national road network throughout County Mayo. 7no. structures required structural assessment to determine the condition of the structures and their load-carrying capacity for HA, HB and SV loading. The assessment of the structures was undertaken in accordance with TII Publications *AM-STR-06056 Stage 1 Structural Assessment of Road Structures* and *AM-STR-06057 Stage 2 Structural Assessment of Sub-Standard Road Structures*.

The assessment of MO-N05-013.00 Knockavrony Bridge comprised the Stage 2 assessment of the reinforced concrete slab section of the structure.

## 1.1 Background information covering the origins for the need for the structural assessment

The need for the Stage 2 structural assessment was outlined in the recommendations of the Stage 1 assessment report, refer to Appendix A of this report for the Stage 1 Assessment Report.

## 1.2 Previous reports and their recommendations

The following table outlines the previous reports, with the Stage 1 assessment report recommending that a Stage 2 assessment be undertaken to the slab section of the structure. The 2024 Principal Inspection report found the structure to be in a good overall condition.

**Table 1-1 Previous Reports**

Document Reference	Document Title
-	Knockavrony Bridge Stage 1 Assessment Report (November 2005)
-	MO-N05-013.00 Knockavrony Bridge PI Report (May 2024)



## 2. Executive Summary

MO-N05-013.00 Knockavrony Bridge carries the N05 National Primary Road over an unknown river approximately 1km east of Ballavary, Co. Mayo. The structure comprises a single span corrugated steel pipe extended to the north by a reinforced concrete deck slab. The corrugated steel arch structure has a width of 25.2m and the concrete deck slab section has a width of 7.5m, giving an overall width out to out of 32.7m along the centreline of the structure. The structure has a square span of 2.6m and a maximum skew span of 3.99m with a skew of 40 degrees. The structure carries a single carriageway measuring 10.15m wide with raised concrete rubbing strips located on both sides of the carriageway. A 500mm high 300mm wide concrete parapet is located at the north elevation with a vehicle safety barrier provided along the south elevation.

The assessment of the structure comprised a Stage 2 assessment of the reinforced concrete slab section of the structure. The need for the Stage 2 structural assessment was outlined in the recommendations of the 2005 Stage 1 assessment report which determined the structure to be incapable of carrying the embankment loading.

A visual inspection for the Stage 2 assessment was undertaken by Atkins in June 2024 with the structure in good overall condition. Structural investigations were also undertaken to the structure by TRIUR Construction Ltd. in July 2024 as follows:

- 1no. trial pit in grass verge above the RC slab for depth of fill and deck exposure
- Covermeter & GPR survey to 3no. areas of deck slab with breakouts
- 4no. concrete cores and strength testing to deck slab
- 3no. pilot holes to confirm deck thickness
- Durability testing to 3no. areas (1no. top, 1no. fascia & 1no. soffit)
- Waterproofing pull off testing
- Covermeter & GPR survey to 2no. areas of abutments with breakouts
- 2no. pilot holes to confirm abutment thickness
- Durability testing to 2no. areas of the abutments

The concrete slab assessment was carried out in accordance with AM-STR-06031 and Chapter 2 of AM-STR-06026. For the Stage 2 structural assessment the slab was modelled as a plate model in MIDAS Civil with the model finding a reduced sagging moment at midspan compared to Stage 1 assessment due to both the reduced depth of fill over the structure and also the presence of reinforcement in the top of the deck slab which is considered to allow for an element of transverse distribution across the slab. The reinforced concrete slab assessment determined the slab to have a sufficient load capacity for 40t accidental loading.

Structure ID	Structure Name	Structure Type	No. of Spans	Span Length	Assessed Capacity (ALL)	HB Capacity	SV Capacity	Accidental loading
MO-N05-013.00	Knockavrony Bridge	Reinforced Concrete Slab	1	3.99m (skew)	-	-	-	40t

Based on the findings of the assessment no further structural assessment measures are deemed required for the structure, with the reinforced concrete slab having sufficient load capacity for 40t accidental loading. The future management of the structure is to comprise principal inspections at regular intervals with term maintenance undertaken to the structure to maintain its condition.

The recommended works for the structure are as follows:



- Increasing the containment height along the north parapet and consideration to the installation of a safety barrier along the north verge over the structure.
- Vegetation clearance to the embankments to maintain a 1m access strip around the structure
- Vegetation removal at the south elevation
- Concrete repairs to the deck slab soffit
- Consideration to the installation of waterproofing to the deck slab over the structure
- Scour repairs to the riverbed under the slab section
- Removal of large stones obstructing river flow in the corrugated pipe section
- Remedial works to the areas of corrosion to the corrugated pipe and consideration for the installation of a concrete invert



## 3. Structure Description

### 3.1 General description of structure

MO-N05-013.00 Knockavrony Bridge carries the N05 National Primary Road over an unknown river approximately 1km east of Ballavary, Co. Mayo. The structure comprises a single span corrugated steel pipe extended to the north by a reinforced concrete deck slab. The corrugated steel arch structure has a width of 25.2m and the concrete deck slab section has a width of 7.5m, giving an overall width out to out of 32.7m along the centreline of the structure. The structure has a square span of 2.6m and a maximum skew span of 3.99m with a skew of 40 degrees.

The structure carries a single carriageway measuring 10.15m wide with raised concrete rubbing strips located on both sides of the carriageway. A 500mm high 300mm wide concrete parapet is located at the north elevation with a vehicle safety barrier provided along the south elevation.

### 3.2 Span arrangements

The slab section of the structure comprises a single span measuring 2.60m square and 3.99m skew. The corrugated pipe section has a 3m span.

### 3.3 Foundation Type

Unknown.

### 3.4 Substructure

The substructure of the slab section comprises mass concrete abutments with concrete wing walls at the north elevation.

### 3.5 Superstructure

The superstructure comprises a corrugated steel pipe extended to the north by a reinforced concrete deck slab.

### 3.6 Articulation arrangements, joints and bearings

The reinforced concrete slab sits directly on top of mass concrete abutments with no connection evident. The slab is therefore assumed to be simply supported.

### 3.7 Parapet

A concrete parapet is present at the north elevation with a vehicle safety barrier present at the south elevation.

### 3.8 Materials

The structure comprises corrugated steel, reinforced concrete and mass concrete.



## 3.9 Changes to Material Properties

No changes to material properties since the previous assessment.

# 4. Stage 1 Structural Assessment Summary

## 4.1 Date of assessment

November 2005

## 4.2 Assessing organisation

Roughan & O'Donovan-Faber Maunsell Alliance

## 4.3 Review of testing undertaken as part of Stage 1 Assessment

The testing undertaken as part of the Stage 1 assessment comprised the following:

- 2 no. concrete cores extracted from the deck edge to determine the concrete strength.
- Covermeter survey at various locations to identify the reinforcing bar spacing and orientation.
- 2no. concrete breakouts to determine articulation details and the reinforcement type, diameter, and cover.
- The pilot drilling of the deck to determine the deck slab thickness.

## 4.4 Review of the results of the Stage 1 Structural Assessment

The Stage 1 assessment was carried out only to the reinforced concrete slab section of the structure with the corrugated structure not subject to assessment.

A 1m strip analysis was carried out in assessing the reinforced concrete slab section as per BD 21/01 and BD 44/95. The analysis found the structure failed in bending for permanent loading only with an adequacy of 76%. The adequacy when also considering accidental loading reduced to 44%. Shear capacity was sufficient for permanent loading only with an adequacy of 133% with a failure in shear when considering accidental loading, giving an adequacy of 71%.

In accordance with BD 21/01 a qualitative assessment was also carried out to substructure with the abutment walls in good condition.



## **4.5 Extent to which the structure failed the assessment**

The structure failed the assessment for dead and superimposed dead loading only due to failure in bending, with an adequacy of 76%.

## **4.6 Detailed commentary on the significance of all of the original assumptions made during the stage 1 assessment in terms of the assessed capacity of the structure**

As the structure does not support the carriageway the structure was not assessed for live loading with accidental loading only considered. The report outlined that the structure did not have capacity to support the embankment loading however.

## **4.7 Mode of failure**

The failure of the reinforced concrete slab occurred due to bending at midspan.

## **4.8 Details of any strengthening works undertaken as a result of the assessment**

No known strengthening works undertaken.

## **4.9 Description of any changes to the load effects or assessment resistance since the original assessment**

The concrete strength results have increased to 45.3N/mm<sup>2</sup> from the stage 1 assessment strength of 30.5N/mm<sup>2</sup>. The maximum depth of fill over the structure is 1m which is reduced from the 2.53m of the stage 1 assessment as the structure does not support the full height of the embankment.

## **4.10 Results of any monitoring or inspections undertaken**

Regular Principal Inspections have been undertaken on the structure since the original assessment. See the most recent inspection report in Appendix A of this report. The Principal Inspections undertaken found the structure to be in a good condition with minor defects found to require routine maintenance. No significant deterioration has been noted since the previous assessment.



## 4.11 The assessed capacity

The structure failed the assessment for dead and superimposed dead loading only due to failure in bending, with an adequacy of 76%. The structure had no live load capacity.

# 5. Stage 2 Structural Assessment Inspection Summary

## 5.1 Detailed description of the findings of the visual inspection

The inspection for assessment of the structure was undertaken in June 2024. Photographs from the inspection are provided in Appendix H of this report. The condition of the structure is outlined below.

### Bridge Surface

The bridge surface is in good condition. See Photograph H-1 to view the surface looking east. Vegetation should be cut back along the north soft verge.

### Expansion Joints

Not applicable.

### Verges

The north and south rubbing strips are in good condition apart from overgrown vegetation. See Photograph H-2 for the north rubbing strip and see Photograph H-3 for the south rubbing strip.

### Parapets

The parapets consist of concrete on the north elevation and a safety barrier on the south elevation. See Photograph H-4 for the north concrete parapet and Photograph H-5 for the south safety barrier.

### Embankments

The embankments are in good condition apart from vegetation growth at both elevations. Vegetation should be cut 1m away from the structure to allow for access. See Photograph H-6 to view the northeast embankment and Photograph H-7 for the southwest embankment.

### Wing/Spandrel walls

The wing walls are in good condition apart from vegetation growth which should be removed. There is undermining evident to the southwest wing wall measuring 400mm. See Photograph H-8 and H-9 for a view of the southwest and southeast wing walls.



## Abutments

The concrete abutments are in good condition apart from algae staining. See Photograph H-10 for the east abutment and see Photograph H-11 for the west abutment.

## Piers

Not applicable.

## Bearings

Not applicable.

## Deck

The concrete deck extension to the north end of the structure is in good condition with recent repairs evident. Spalling is evident to the west end of the deck measuring 0.2m x 0.17m with exposed reinforcement also present. A void is also present at the base of the headwall of the north elevation with a length of 0.75m. 500mm long concrete spalling is also evident to the slab soffit at the interface with the pipe section. As noted in previous inspections a 15-20mm deflection is evident to the north elevation of the slab but appears to be a defect from the construction stage with no distress noted in the slab soffit.

See Photograph H-12 for the deck looking south and Photograph H-13 for the spalling to the deck slab at the west abutment. See Photograph H-14 for a view of the spalling to the north headwall and H-15 for the spalling with exposed reinforcement at the interface with the pipe section.

## Beams

Not applicable.

## Riverbed

The riverbed is in good condition apart from large stones located in the corrugated arch section which is obstructing water flow. Scour is also present in the concrete extension with a 0.4m deep scour hole beyond the north elevation. See Photograph H-16 to view the riverbed beneath the corrugated arch structure with large stones present. See H-17 and H-18 to view the riverbed beneath the concrete deck extension and the scour evident.

## Other Elements

The corrugated pipe structure is in good condition with algae staining present throughout. There is corrosion evident to the pipe walls along water level. Minor calcite staining has also formed to the bolts of the structure.

See Photographs H-19 to H-22 for a view of the corrugated arch and the defects outlined above.

## Overall Structure

The structure is in good condition overall. See Photograph H-23 for the north elevation of the structure and Photograph H-24 for the south elevation of the structure.



## 5.2 Identification and justification of the condition factor used in the assessment calculations for each structural element

The condition factor for the reinforced concrete slab is taken as 0.9 for assessment purposes as a conservative measure based on the defects noted to the deck slab.

## 5.3 Detailed description of the testing undertaken

The testing undertaken to the structure for the Stage 2 assessment by TRIUR Construction Ltd. in July 2024 comprised the following:

- 1no. trial pit in grass verge above the RC slab for depth of fill and deck exposure
- Covermeter & GPR survey to 3no. areas of deck slab with breakouts
- 4no. concrete cores and strength testing to deck slab
- 3no. pilot holes to confirm deck thickness
- Durability testing to 3no. areas (1no. top, 1no. fascia & 1no. soffit)
- Waterproofing pull off testing
- Covermeter & GPR survey to 2no. areas of abutments with breakouts
- 2no. pilot holes to confirm abutment thickness
- Durability testing to 2no. areas of the abutments

For further information on the structural investigations refer to Appendix E of this report.

## 5.4 Results of all testing undertaken

The depth of the fill above the concrete slab at the trial pit location was found to be 500mm. 3no. pilot holes drilled through the reinforced concrete deck found the thickness of the deck varies from 260mm to 290mm. The estimated worst credible strength from the recent strength testing was found to be 45.3 N/mm<sup>2</sup>. The top reinforcement found in the slab comprises 16mm diameter bars at 200mm spacing in the longitudinal direction and 230mm spacing in the transverse direction. The bottom layer of reinforcement comprises longitudinal reinforcement of 22mm diameter bars at 180mm average spacing running approximately parallel to the north elevation. The investigation confirmed no transverse reinforcement in the soffit of the slab. All reinforcement comprises plain round bars.

For full results of the structural investigations refer to Appendix E of this report.

## 5.5 Summary of safety partial factors used in the assessment

For the concrete, the values of  $\gamma_m$  is taken as 1.2 considering worst credible strengths which is taken from Table 4A (4.3.3.3.) of AM-STR-06031. For reinforcing steel the  $\gamma_m$  is taken as 1.15.

The partial safety factors taken from *AM-STR-06030 Appendix A* are represented below in the Table 5-1. Refer to Appendix G calculations for more details.



**Table 5-1 - Partial Safety Factors for RC Slab Assessment**

Loading	$\gamma_{f3}$ for ULS	$\gamma_{fL}$ for ULS
Dead Load	1.1	1.15
Super Imposed Dead Load	1.1	1.75
Soil Fill	1.1	1.2
Horizontal Earth Pressure	1	1
Accidental Vehicle Loading	1.1	1.5

## 5.6 Summary of all material properties used in the assessment

The estimated worst credible concrete strength of the reinforced concrete deck slab is determined as 45.3 N/mm<sup>2</sup>. This is based on compression testing data of concrete core samples and is derived in accordance with *AM-STR-06031*.

The structural investigation identified that the reinforcement in the deck slab is plain round bars. As the reinforcement are plain round bars the steel strength was taken as 250N/mm<sup>2</sup> in accordance with *AM-STR-06026* Cl. 4.4 which states that for reinforcement after the 1960s the characteristic strength should be taken as per the design codes of the period. BS 4449:1969, 1978 & 1988 gives a characteristic strength of 250 N/mm<sup>2</sup> which is to be used in the Stage 2 assessment on the basis the structure was constructed after 1969. This value was also used in the Stage 1 assessment.

The unit weight of reinforced concrete is 25kN/m<sup>3</sup>.

## 6. Assessment Method

### 6.1 Summary of analysis methodology undertaken as part of Stage 1 Structural Assessment

The structure was assessed in accordance with the requirements of BD21/01, BD44/95, and the recommendations of Advice Notes BA44/96 and BA16/97. The concrete slab was analysed using a strip method and standard formulae for moments and shears. An isolated 1.0 metre strip of slab was considered. As the structure does not support the carriageway the structure was not assessed for live loading with accidental loading considered.



## 6.2 Detailed description of method of analysis undertaken for Stage 2 analysis including justification as to how this has led to an increase in the assessed capacity for the superstructure, substructure and foundations

The concrete slab assessment was carried out in accordance with *AM-STR-06031* and Chapter 2 of *AM-STR-06026*. For the Stage 2 structural assessment the slab was modelled as a plate model in MIDAS Civil with the model finding a reduced sagging moment at midspan compared to Stage 1 assessment due to both the reduced depth of fill over the structure and also the presence of reinforcement in the top of the deck slab which is considered to allow for an element of transverse distribution across the slab. The reinforced concrete slab assessment determined the slab to have a sufficient load capacity for 40t accidental loading.

## 6.3 Description of the model and software used for the analysis

The reinforced concrete slab was analysed with a finite element model using MIDAS Civil software. The structure was analysed as a plate model.

The diagram of the model and the model inputs are shown in Appendix F of this report.

## 6.4 Assessment live loading

Assessment live loading was not considered in the assessment as the slab section of the structure is located off the carriageway. Accidental loading was considered as per *AM-STR-06026* Cl 5.35.

## 6.5 Abnormal loading

Abnormal loading was not considered as part of the assessment due to the location of the slab section off the carriageway. Any abnormal loads crossing the structure will be carried by the corrugated pipe section of the structure.

## 6.6 Additional loading requirements

Dead and superimposed dead loads was applied to the structure based on the information gathered during the site investigation works and the inspection for assessment.



# 7. Assessment Commentary

## 7.1 Assumptions made during the Stage 2 Structural Assessment

The deck slab has been assumed to be simply supported due to no connection being evident between the slab and abutments and the abutments being of mass concrete construction.

The concrete slab does not support the carriageway but is not protected from vehicular traffic by an effective barrier. It is therefore subject to accidental loading for purposes of assessment.

The reinforcement arrangement found at the test locations has been assumed to be consistent across the deck slab.

The site investigations identified that the reinforcement in the deck slab are smooth plain bars with a steel strength of 250 N/mm<sup>2</sup> assumed for the purposes of assessment in accordance with AM-STR-06026.

The maximum depth of fill over the slab is 1m based on a recent topographical survey.

## 7.2 Significance of these assumptions in relation to the overall capacity of the structure or element

The load capacity of the reinforced concrete slab structure has been found to be sufficient for 40t accidental loading in the existing condition with the assumptions listed above.

# 8. Assessment Results

The load capacity of the reinforced concrete slab structure has been found to be sufficient for a 40T accidental loading in the existing condition. The results of the assessment are shown in Table 8-1 below as per the guidance from AM-STR-06057.

Table 8-1 - Assessment Results for Reinforced Concrete Slab

Element	Location in Structure	Load Effect	R <sub>A</sub> *	S <sub>D</sub> *	S <sub>ACC 40T</sub> *	R <sub>A</sub> */S <sub>A</sub>
Reinforced Concrete Slab	North Elevation	Moment near Support (kNm)	85	11	13	6.6
		Max. Sagging Moment (kNm)	85	42	67	1.3
		Max. Shear (kN)	544	150	221	2.5

Where

R<sub>A</sub>\* = Assessment Resistance (flexure, shear etc.)

S<sub>D</sub>\* = Assessment load effects due to dead and superimposed dead loads



- $S_{ACC\ 40T^*}$  = Load effect due to Accidental Combination 40T loading (ULS)  
 $S_A^*$  = Assessment load effects (Maximum of ULS Combination)  
 $R_A^*/S_A^*$  = Structural Assessment Factor (shown for the critical case from the ULS cases)

The detailed table showing summary of checks for each load case is given in Appendix G.

**Table 8-2 - Assessment summary for Structure**

Structure ID	Structure Name	Structure Type	No. of Spans	Span Length	Assessed Capacity (ALL)	HB Capacity	SV Capacity	Accidental loading
MO-N05-013.00	Knockavrony Bridge	Reinforced Concrete Slab	1	3.99m (skew)	-	-	-	40t

## 9. Recommendations

Based on the findings of the assessment no further structural assessment measures are deemed required for the structure, with the reinforced concrete slab having sufficient load capacity for 40t accidental loading. The future management of the structure is to comprise principal inspections at regular intervals with term maintenance undertaken to the structure to maintain its condition.

The recommended works for the structure are as follows:

- Increasing the containment height along the north parapet and consideration to the installation of a safety barrier along the north verge over the structure.
- Vegetation clearance to the embankments to maintain a 1m access strip around the structure
- Vegetation removal at the south elevation
- Concrete repairs to the deck slab soffit
- Consideration to the installation of waterproofing to the deck slab over the structure
- Scour repairs to the riverbed under the slab section
- Removal of large stones obstructing river flow in the corrugated pipe section
- Remedial works to the areas of corrosion to the corrugated pipe and consideration for the installation of a concrete invert



# Appendices

# Appendix A. Archive Information about the Structure



# Knockavrony Bridge

Structure ID: MO-N05-013.00

## Stage 1 Assessment Report



*November 2005*

**Client:**  
National Roads Authority  
St. Martin's House  
Waterloo Road  
Dublin 4

**Consulting Engineer:**  
Roughan & O'Donovan  
FaberMaunsell Alliance  
Arena House  
Arena Road  
Sandyford  
Dublin 18

**Knockavrony Bridge**  
**Structure ID: MO-N05-013.00**  
**Stage 1 Assessment Report**

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# 1 Location Map



## 2 Executive Summary

Knockavrony Bridge on the N05 in Mayo has, at the request of the National Roads Authority (NRA), had a preliminary structural assessment completed in accordance with the relevant United Kingdom Department of Transport and NRA Standards documents. This report details the findings of the assessment.

Knockavrony Bridge is a single corrugated steel pipe which has been extended by a simply supported reinforced concrete slab. The pipe section falls outside the NRA commission for Stage 1 Assessments, therefore, only the concrete frame has been assessed here.

A structural assessment, in accordance with BD 44/95 was carried out based on data collected from a geometric survey of the bridge as well as a structural investigation.

The structure is at present in good condition, however, the reinforced concrete slab was calculated to be incapable of sustaining the dead load from the embankment above.

A stage 2 Assessment analysing strengthening methods is recommended for the reinforced concrete slab. This total estimated cost of this is €7,500 + VAT.

There are no parapets in this location, only a vehicular guardrail on the northern side of the carriageway. Therefore, it is recommended that a safety barrier system be installed in the southern verge at a total estimated cost of €5,000 + VAT.

### 3 Introduction

Knockavrony Bridge (MO-N05-013.00) is located on the N05, between Bellavary and Bohola, approximately 1km east of Bellavary. This is a relatively lightly trafficked section of the National Primary Road network with an estimated (2003) annual average daily traffic (AADT) figure of 6,242, 8.3% of which are HGV vehicles (National Road Authority's RT620 "National Roads & Traffic Flow").

No records of previous structural assessments of the existing bridge structure have been made available at this time. Following on from the Inventory and Principal Inspection Report, produced by Roughan & O'Donovan-Faber Maunsell Alliance on the 2nd July 2002, the National Roads Authority commissioned ROD-FM to carry out a Stage 1 Structural Assessment of Knockavrony Bridge. The Stage 1 Structural Assessment is to determine the load carrying capacity of the existing structure and to make any necessary recommendations regarding its structural capacity.

### 4 Description of Structure

The combined Inventory and Principle Inspection Report indicates that the bridge consists primarily of a 3.00 metre spanning corrugated steel pipe culvert approximately 23 metres long carrying the N05 over the Strade River. The corrugated pipe is skewed at an angle of approximately 30 degrees to the carriageway above. The structure has been extended to the north by means of a single span reinforced concrete slab. This widening is skewed to the pipe at approximately 15 degrees and has a 4.05 metre skew span and is approximately 7 metres wide. The pipe culvert falls outside of the National Roads Authority commission for Stage 1 structural assessments as it is deemed to be a buried structure. Only the reinforced concrete portion of the structure has been considered in this report.

The findings of the Principle Inspection state that the structure is in very good condition with no significant structural defects found. Based on this information, an inspection for assessment was carried out on 26th March 2003 with a further site investigation on 13th June 2005, as required by the "Stage 1 Assessment Methodology Report – Revision A", to determine the reinforcement details in the concrete slab. These are described below in sections 5 and 6.

The width of the carriageway was measured to be 7.60 metres, and from BD 21/01 Table 5.1 this is equivalent to 3 notional lanes of traffic for HA assessment loading.

A sketch showing the general arrangement of the structure has been included as Appendix A. General photographs showing the current condition of the bridge have been included as Appendix B.

### 5 Visual Inspection of Structure

In order to determine the reinforcement arrangement in the deck slab, the overall condition factor for the structure, the importance of the specific defects noted during the Principle Inspection and to confirm the structural dimensions as recorded in the Inventory Report, an inspection for assessment in accordance with Chapter 2 of BD 21/01 was carried out by Mr Joe Kelly and Mr Steve Lowe on 26th March 2003. This inspection consisted of; visual observations; a photographic record; hammer tapping survey to identify areas of delamination and planar cracking in the concrete slab; the

establishment of the spacing and cover of the steel reinforcement using a cover meter; excavation of trial pits in the carriageway verge to verify the slab thickness; and a level survey to determine the depth of fill.

The size and type of steel bars used as reinforcement was not determined as no bars were exposed. The spacing (s) and cover of the bars were determined using a cover meter. The findings of this inspection are outlined in Table 1 below;

Articulation		Simply Supported
Effective Span	$L_e$ (m) =	4.380
Rebar Arrangement - midspan	$\phi$ (mm) =	unknown
	s (mm) =	200
	cover (mm) =	45
Rebar Arrangement - supports	$\phi$ (mm) =	unknown
	s (mm) =	200
	cover (mm) =	45
Slab Thickness	d (m) =	0.280
Maximum Depth of Fill	h (m) =	2.530
Minimum Depth of Fill	h (m) =	0.400

**Table 1: Summary of Reinforced Concrete Slab**

The measured dimensions are consistent with those recorded during the previous inspection. However, the measurements taken during the Inspection for Assessment have been used in the structural assessment.

The reinforced concrete frame lies beneath the embankment to the N05. The maximum depth of fill was taken as the difference between the level of the top of the embankment and level of the top of the slab. In fact, the reinforced concrete frame section of the structure ends at a point below the sloping embankment. As this point is difficult to determine accurately, the maximum depth of the embankment is used in the assessment as a conservative measure.

## 6 Site Investigation Results

In accordance with Section 3.2 of the "Stage 1 Assessment Methodology Report", issued by the National Roads Authority in October 2004, intrusive investigations were carried out on the bridge because no details of the bridge were available.

The structural investigation carried out on 13th June 2005 consisted of conducting two breakouts from the concrete at two non-critical locations from the soffit of the slab to determine the reinforcement type and layout. Two concrete cores were also retrieved to determine the concrete strength. This investigation determined that no steel is present in the top face of the slab and, therefore, the structure is not a concrete frame as surmised by both the Principal Inspection and the Inspection for Assessment but is in fact a simply supported reinforced concrete slab. The concrete strength was found to be a minimum of 30.5 N/mm<sup>2</sup> and the reinforcement was determined as being 22mm diameter mild steel bars running parallel to the deck edge at an average spacing of 178mm. The cover to these bars was measured to be 35mm and the depth was determined, by drilling, to be 300mm deep.

The bridge carriageway was observed to be in good condition with only minor evidence of wear in the form of rutting in the wheel tracks. The alignment of the carriageway in this location is also good being situated on a long straight section of constant gradient.

The concrete slab is in good condition at present with no signs of structural distress.

At present there are no parapets at this location, however, there is a vehicular guardrail on the northern side of the carriageway.

## 7 Assessment of Structure

The structural assessment has been carried out based on the following United Kingdom Department of Transport (DoT) documents;

- (i) Departmental Standard BD 21/01, "The Assessment of Highway Bridges and Structures".
- (ii) Departmental Advice Note BA 16/97, " The Assessment of Highway Bridges and Structures ".
- (iii) Departmental Standard BD 44/95, "The Assessment of Concrete Highway Bridges and Structures".
- (iv) Departmental Standard BD 34/90, "Technical Requirements for the assessment and strengthening Programme for Highway Structures. Stage 1 - Older Short Span Bridges and Retaining Structures".
- (v) Departmental Standard BD 37/01 "Loads for Highway Bridges".
- (vi) Departmental Standard BD 52/93, "Design of Highway Bridge Parapets".

In addition, the following technical documents have been used to assess the adequacy of the structure;

- (vii) British Standard BS 5400 Part 4: 1990, " Steel, Composite and Concrete Bridges – Part 4: Code of practice for design of concrete bridges".
- (viii) National Roads Authority, "Stage 1 Assessment Methodology Report – Revision A" issued May 2005.

### 7.1 Assumptions

- No assessment of the capacity of the river channel during flood conditions has been made at this preliminary stage.
- Concrete slab dimensions were measured on site. The reinforcement details in the slab were determined from the structural investigation outlined in section 6.

### 7.2 Assessment Loading

An isolated 1.0 metre strip of slab was considered. Dead load and superimposed dead loads were calculated using the unit weights and recommendation for the depth of fill contained in BD 21/01. As the structure does not lie beneath the carriageway

and there is a vehicular guardrail at the top of the embankment the structure was not assessed for any live loads.

### 7.3 Material Properties

Material properties used in the assessment were taken from the structural investigation carried out on 13th June 2005.

The following material strengths were adopted:

Insitu concrete:	30.5 N/mm <sup>2</sup>
Mild steel reinforcing bars:	250 N/mm <sup>2</sup>

The concrete and steel strengths were treated as representing worst credible values, and the partial factors used in the assessment were those specified in the standards for use with worst credible strengths.

### 7.4 Method of Analysis

The preliminary structural assessment of the concrete slab has been carried out using an elastic analysis using uncracked section properties ensuring that individual sections can resist the elastic stress resultants. The calculations are provided in Appendix C.

### 7.5 Substructure

The abutments have been assessed qualitatively by considering the condition of the structure and the significance of any defects in accordance with the "Sub-structure, foundations and walls" clauses of Chapter 8 of BD 21/01.

## 8 Conclusions

### 8.1 Reinforced Concrete Slab

The assessment results are presented as a Stress Index, which is the ratio of calculated assessment load effect [SA\*] to the respective assessment resistance [RA\*]. A Stress Index of 1.0 or less indicates full compliance with the standard. If the combination of loading and capacity occurs in service such that the Stress Index exceeds unity, this indicates a reduction in the safety factors inherent in the Codes of Practice or Standards; the implications of such a reduction would be individually assessed with regard to the safety of the structure.

Table 2 summarises the stress indices obtained from the assessment calculations.

Assessment Results	Stress Index in Bending	Stress Index in Shear
Reinforced Concrete Slab Accidental Wheel Loading	1.32	0.75

**Table 2: Summary of Stress Indices**

From Table 2, above, the structure was assessed to be incapable of sustaining the dead load from the fill in the embankment above.

## 8.2 Bridge Substructure

In accordance with BD 21/01 a qualitative assessment was carried out based on the results of the visual inspection. The abutment walls showed no signs of flexural cracking or differential settlement, which would be indicative of structural distress due either to overload, or movement of the substructure.

## 9 Recommendations

The results of the structural assessment can be summarised as follows;

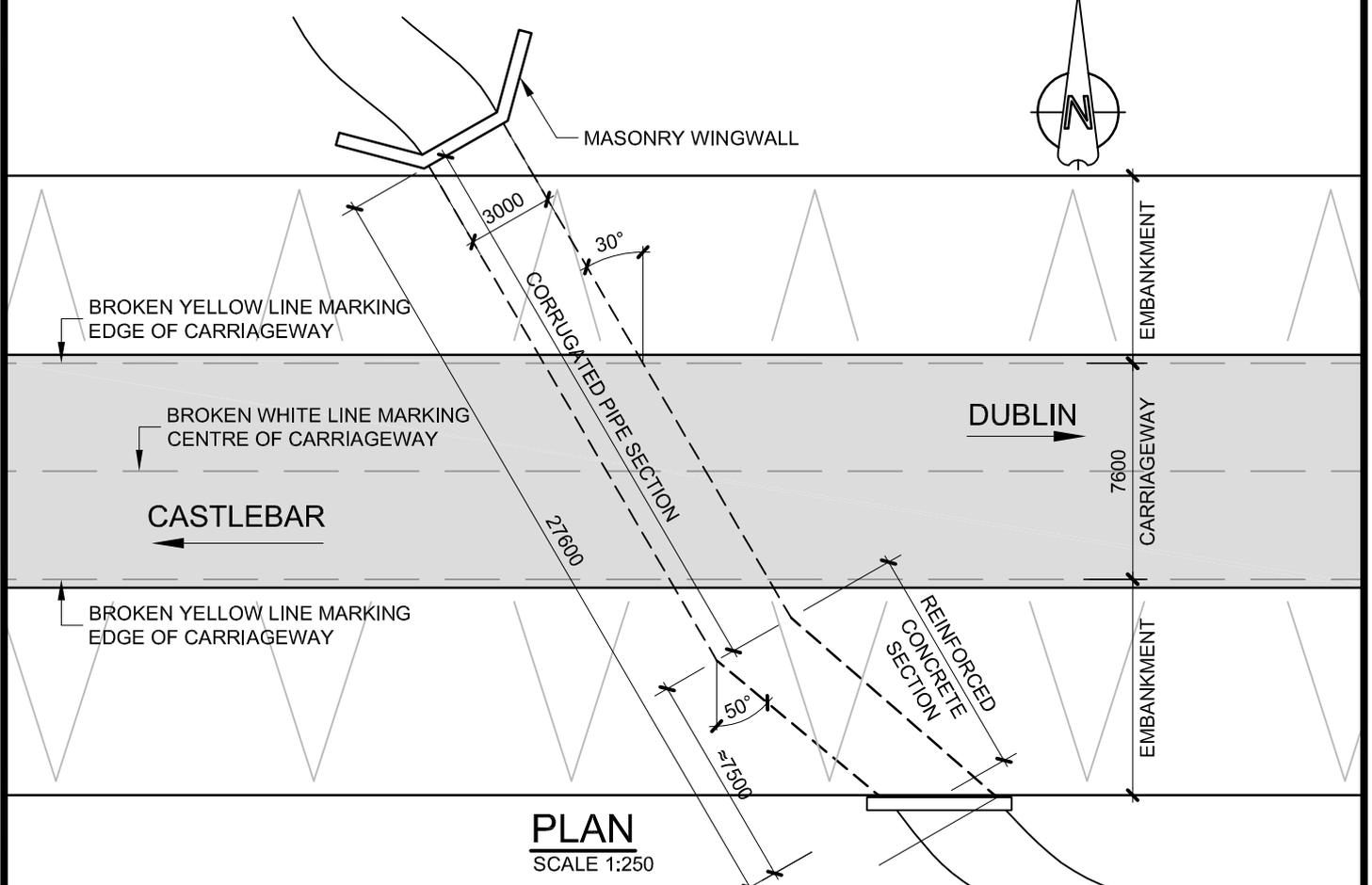
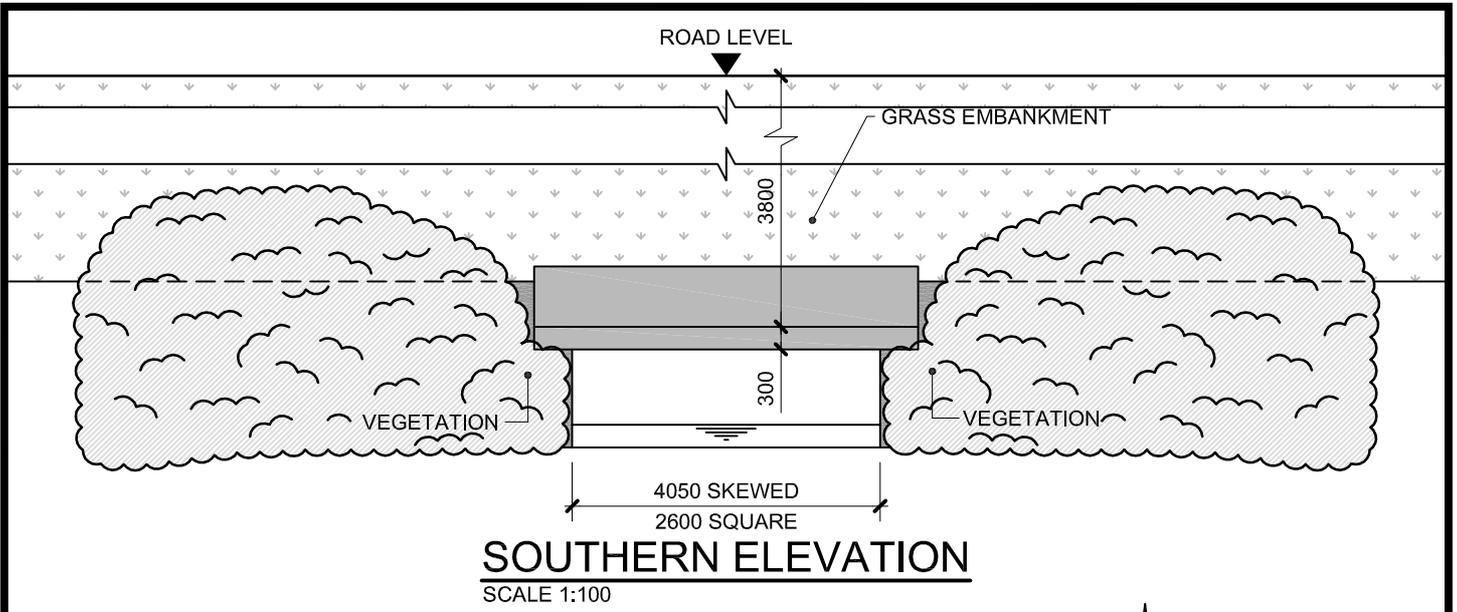
- (i) The structure was assessed to be incapable of carrying the required accidental wheel loading.
- (ii) There are no signs of any structural distress in the bridge substructure.

Following our assessment of Knockavrony Bridge, it is recommended that a Stage 2 Assessment of the structure be carried out to determine strengthening methods for the reinforced concrete slab. The total estimated cost of this is €7,500 + VAT.

Further to this, there is only a vehicular guardrail on the northern side of the carriageway and it is recommended that a vehicular guardrail with an N2 level of vehicular containment be installed in the southern verge in accordance with NRA TD19/01. The total estimated cost for these works is €5,000 + VAT.

## **Appendix A – List of Drawings and Sketches**

There are no record drawings available for this structure and, therefore, sufficient data was retrieved during the inspection for assessment to allow the structural assessment to be carried out. However, a sketch showing the general arrangement of the structure has been produced showing the main findings of the inspection and is included as Figure 1.



 <p>Consulting Engineers Arena House, Arena Road, Sandyford, Dublin 18. Tel: +353 1 2940800, Fax : +353 1 2940820 e-mail : info@rod.ie www.roughanodonovan.com www.fabermaunsell.com</p>	<b>Roughan &amp; O'Donovan-FaberMaunsell Alliance</b>			
	Project Title			
	EIRSPAN BRIDGE ASSESSMENTS PHASE 1			
	Drawing Title			
	KNOCKAVRONY BRIDGE - MO-N05-013.00			
Date	Scale	CAD File	Project No.	
08.09.05	AS SHOWN	MO-N05-013.00	04.269	
Drawn	Checked	Approved	Drawing No.	Rev.
LC	PM	JOD	MO-N05-013.00	

## **Appendix B – Photographs**



**Photograph 1: View of the Bridge from the South**



**Photograph 2: General View of Carriageway Facing East**

## **Appendix C – Site Investigation Results**



Henderson Thomas Associates Ltd

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Structural Investigation  
Experts

**Roughan & O'Donovan - Faber Maunsell Alliance**  
**Arena House**  
**Arena Road**  
**Sandyford**  
**Dublin 18**

**For the attention of Mr Paul Mullins**

28<sup>TH</sup> July 2005

File No - L/0543/2005/R14/DH

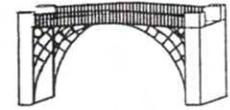
Eirspan Bridge Assessment - Testing In Mayo

**REPORT ON THE INVESTIGATION OF KNOCKAVRONY**  
**BRIDGE (MO - N05 - 013)**

Report prepared by

A handwritten signature in black ink, appearing to read 'D Henderson'.

**D Henderson (Director)**  
**For Henderson Thomas Associates Ltd**



Structural Investigation  
Experts

<b>1.0 INTRODUCTION</b>	<b>page 3</b>
<b>2.0 BACKGROUND</b>	<b>page 3</b>
<b>3.0 SITE WORKS</b>	<b>page 3</b>
<b>4.0 LABORATORY TESTING</b>	<b>page 3</b>
<b>5.0 DISCUSSION OF SITE WORKS</b>	<b>page 4</b>
<b>6.0 QUALITY STATEMENT</b>	<b>page 4</b>
<b>APPENDIX A</b>	<b>page 5 to 8</b>
<b>APPENDIX B</b>	<b>photo page 1 to 4</b>

## 1.0 INTRODUCTION

Acting upon the written instructions of Roughan & O'Donovan - Faber Maunsell Alliance, Henderson Thomas Associates Limited attended the above named bridge to carry out an investigation.

All concrete core samples recovered as part of this investigation were given our laboratory reference number - SSN 0242.

Structural and geotechnical matters are outwith the scope of this report.

All opinions expressed are outside the scope of our UKAS accreditation.

## 2.0 BACKGROUND

We understand that Roughan & O'Donovan - Faber Maunsell were commissioned to carry out structural load carrying assessments on a package containing a number of bridges including Knockavrony Bridge.

To enable the assessment to be carried out certain as built details were required by Roughan & O'Donovan - Faber Maunsell Alliance. Henderson Thomas Associates were commissioned to determine these as built details and to carry out concrete strength testing on recovered core samples.

The structure is an Armco culvert that has been extended at the downstream side with a skewed, simply supported reinforced concrete slab.

This report presents the results of the site works undertaken and the laboratory testing carried out on the recovered concrete core samples.

## 3.0 SITE WORKS

The site works consisted of the following:-

- a) The extraction of 2 No. concrete core samples (C1 and C2). The cores were both cut horizontally from the downstream extension deck edge.
- b) The carrying out of cover meter scans at several locations to identify the reinforcing bar spacing and orientation (the located bars were marked up on the concrete surface using a yellow marker crayon).
- c) The localised breaking out of the concrete at two locations (BO1 and BO2) to determine the bar type, diameter and concrete cover.
- d) The taking of insitu photographs.
- e) The pilot drilling of the deck to determine the deck slab thickness.
- f) The reinstating of all core holes and breakouts with SBD Mulsifix (structural grade) repair mortar.

The locations of the areas investigated are presented in appendix A

#### **4.0 LABORATORY TESTING**

The 2 concrete cores were compression tested under subcontract. The testing confirmed the cores to have the following estimated in-situ cube strengths :-

C1 - 30.5 N/mm<sup>2</sup>

C2 - not tested

Core C2 broke up during sawing to prepare the test cylinder as because it was so poorly compacted.

#### **5.0 DISCUSSION OF SITE WORKS**

The results of the site works are presented in the figure in Appendix A.

The concrete deck slab thickness was shown to be 300mm.

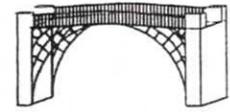
No transverse bars were located by the cover meter or at the breakout locations.

#### **6.0 QUALITY STATEMENT**

We confirm that all reasonable skill and care has been exercised in the production of this report.

This report is for the sole use of the named clients (NRA and Roughan & O'Donovan - Faber Maunsell Alliance) and no part of this report should be reproduced without written consent of Henderson Thomas Associates Ltd.

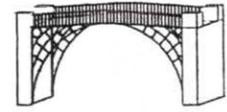
All comments and opinions expressed relate only to the location at which data or a sample was located and no influence should be made to any other part of the structure or any other structure.



Structural Investigation  
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**APPENDIX A**  
**FIGURES AND LAB RESULTS**

Eirspan - Knockavrony Bridge

Structural Investigation  
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**CERTIFICATE OF LABORATORY TESTING  
COMPRESSIVE STRENGTH OF HARDENED CONCRETE CORES**

<b>Client</b>	Roughan & O'Donovan - Faber Maunsell Alliance
<b>Site</b>	Knockavrony Bridge
<b>Location</b>	Horizontally into deck edge.
<b>Sampled By</b>	D Williamson/D Henderson
<b>Sample No.</b>	SSN 0242 (for both cores)
<b>File No</b>	L/0543/R14/2005
<b>Date tested</b>	20/7/2005

Core No.	C1
Orientation (V/H)	H
Excess voids (%)	2.5
Reinforcing (Y/N)	N
Diameter (mm)	76
Capping material	cem
Distance from core end (mm)	40
Density (kg/m <sup>3</sup> )	2390
Strength (N/mm <sup>2</sup> )	31.0
Estimated insitu cube strength (N/mm <sup>2</sup> )	30.5
Failure - mode	norm

Photographs of the cores are presented in appendix B.

Core C2 was too poorly compacted to compression test.

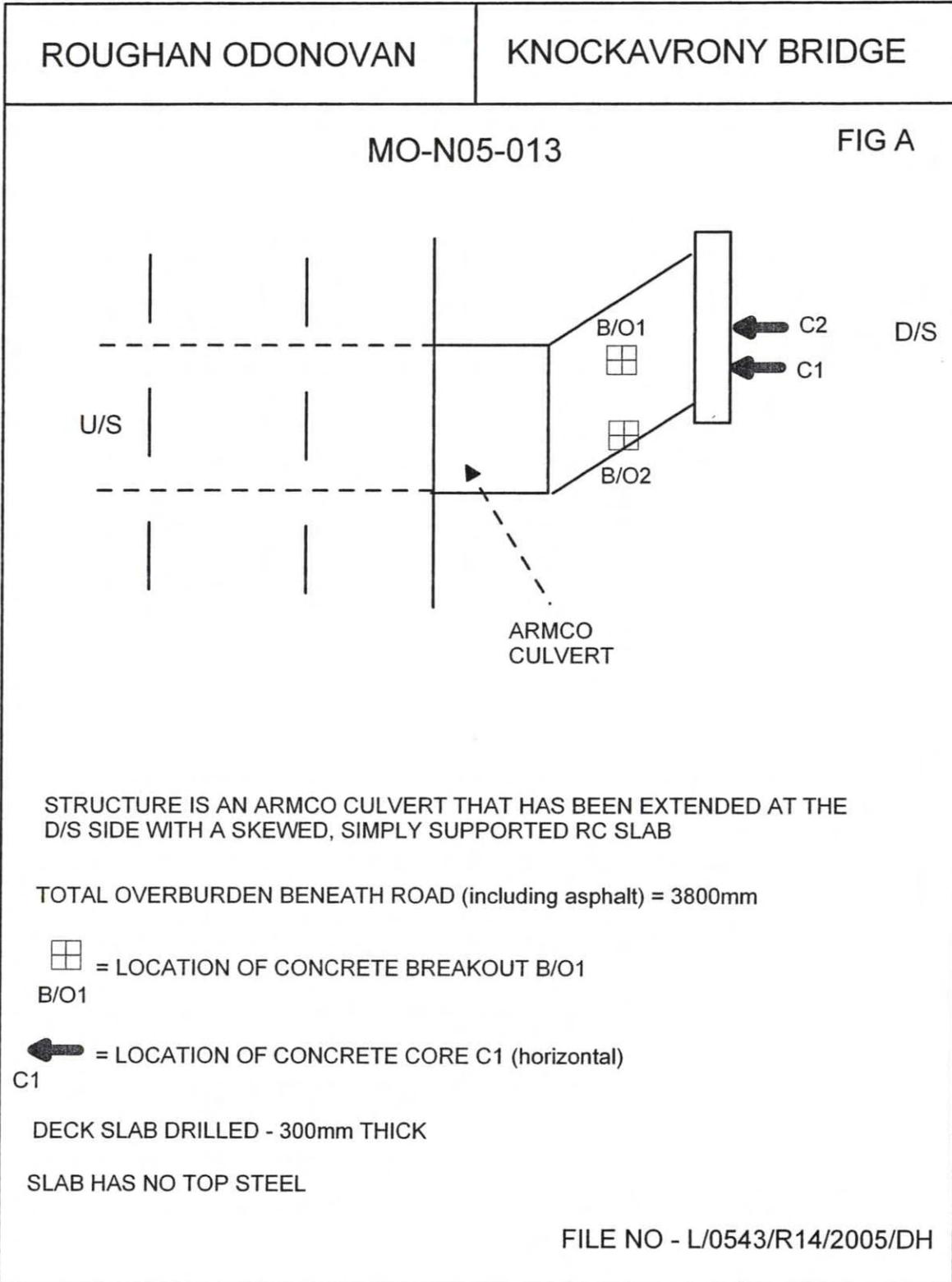
Signed

**D Henderson (Director)**

**For Henderson Thomas Associates Ltd**

**Comments:-**

Cores were of a non standard size.  
Testing was carried out under subcontract.  
Capping material was HAC cement.  
Cores were stored in water three days prior to test.  
Testing in accordance with BS 1881.

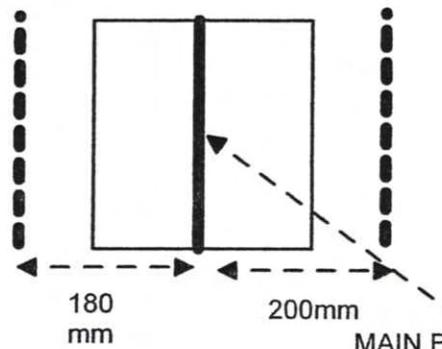


ROUGHAN ODO NOVAN

KNOCKAVRONY BRIDGE

MO-N05-013

FIG B



MAIN BAR - MILD STEEL  
RUNS PARALLEL TO DECK EDGE  
COVER = 35mm  
DIAMETER = 22mm  
@ 180,200,180,150,180mm C/C

NO TRANSVERSE BARS WERE LOCATED BY THE COVERMETER OR AT THE  
BREAKOUT LOCATION

MAIN BAR SPACING WAS THW SAME AT MIDSPAN AS AT THE ABUTMENT

FILE NO - L/0543/R14/2005/DH

## **Appendix B**

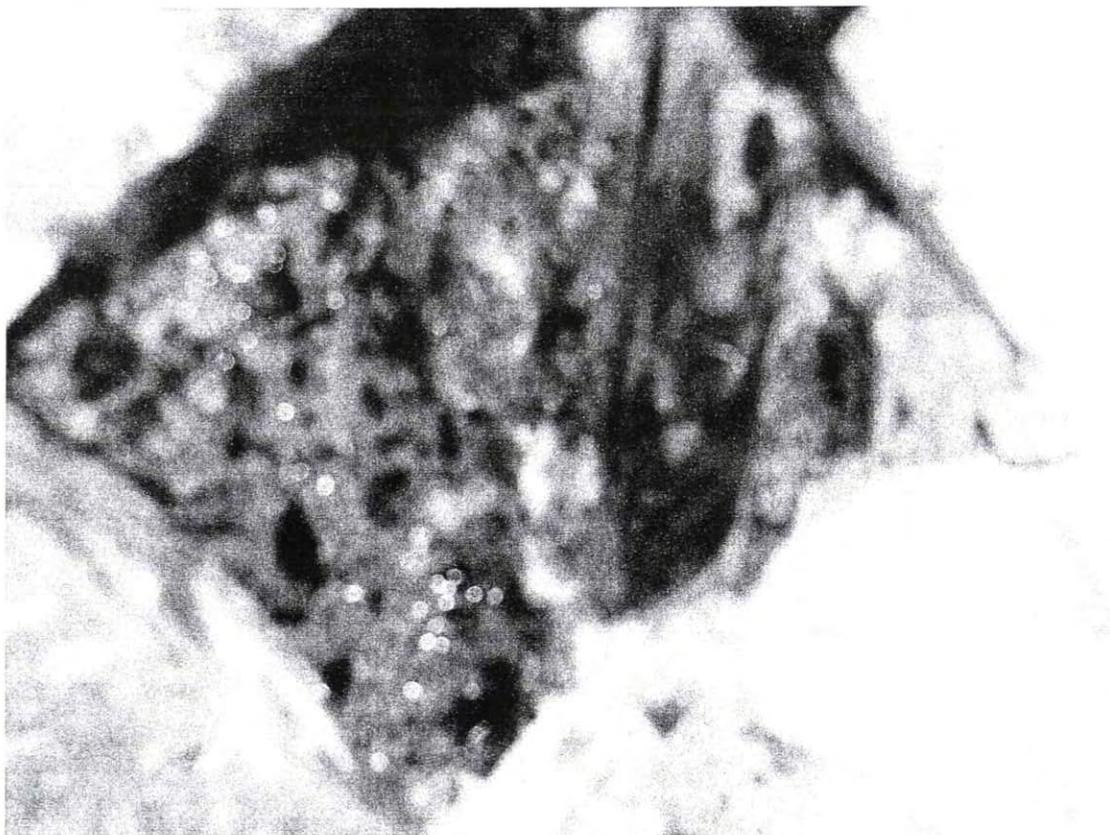
### **Photo log**



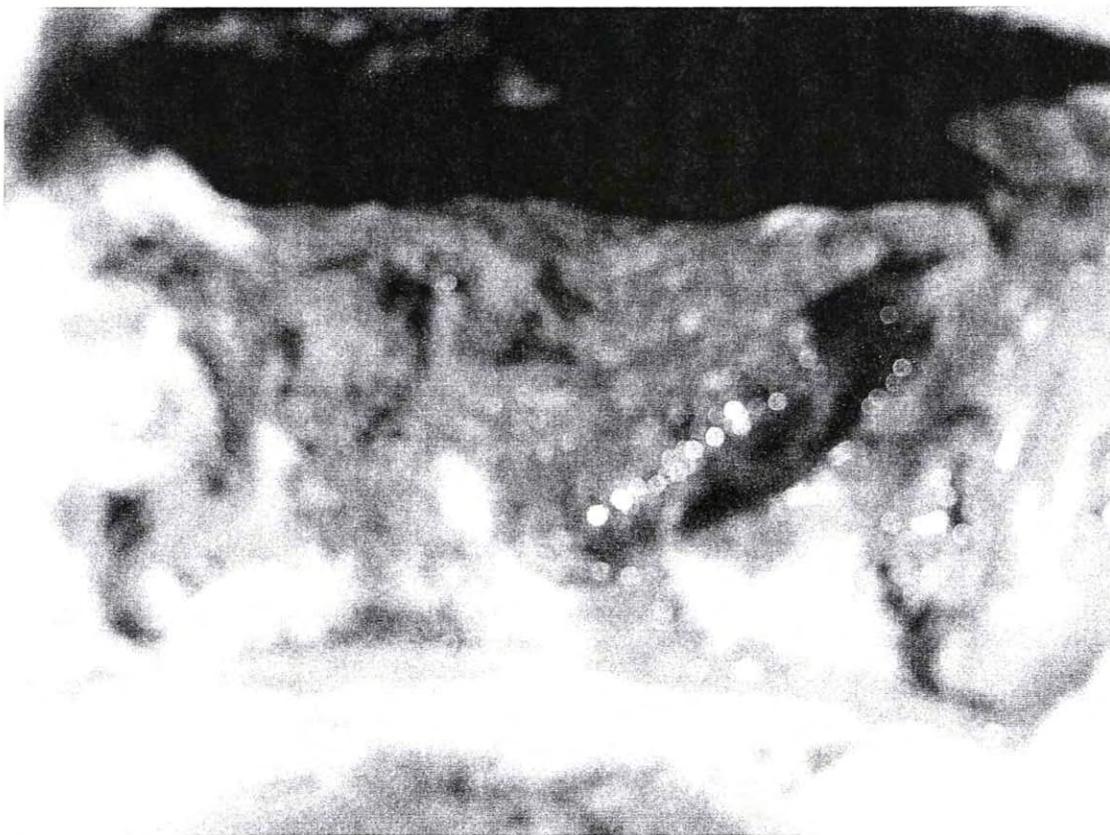
**Plate 1 - Showing general view Knockavrony bridge .**



**Plate 2 - Showing general view of Knockavrony bridge.**



**Plate 3 - Showing general view of B/O1.**



**Plate 4 - Showing a general view B/O2.**

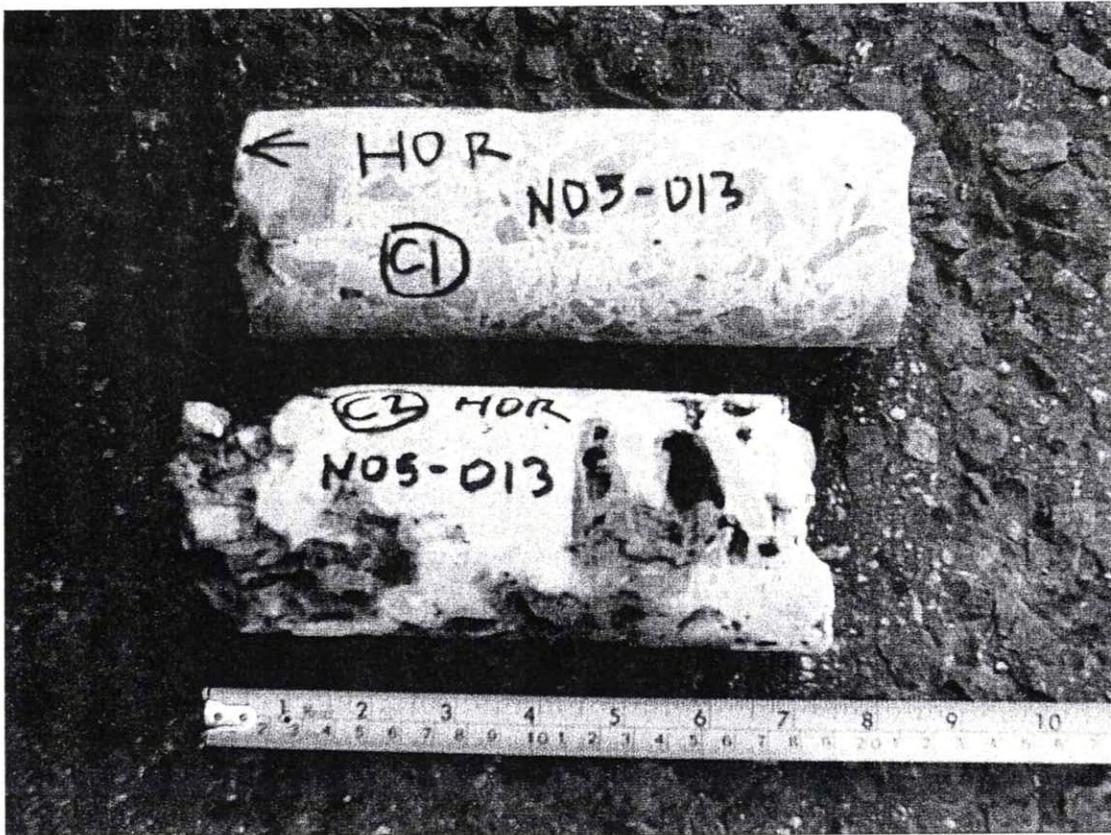


Plate 5 - Showing C1 & C2.

## **Appendix D – Calculations**



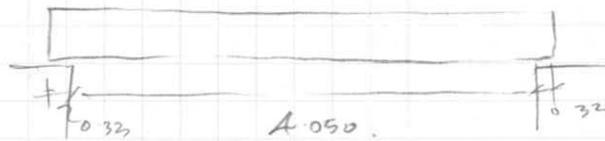
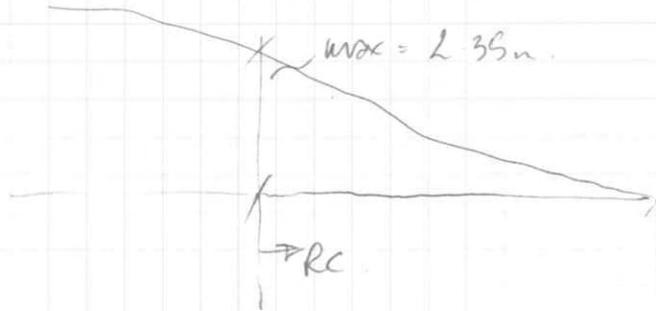
Ref

Calculations

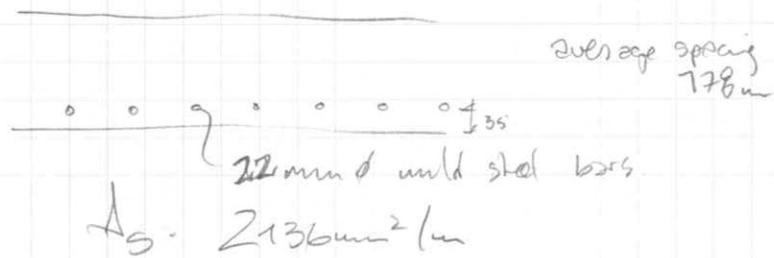
Output

ASSESSMENT OF REINFORCED CONCRETE SLAB

Reinforced concrete slab is underneath the  
grass verge and therefore, should be  
only assessed for accidental wheel loading.



Effective length,  $l_E = 4.27m$ .



Job Title EUROPEAN BRIDGE ASSESSMENTS  
-TRANSHE

Job No.  
04.269

Ref	Calculations	Output
	<p><u>LOADING</u></p> <p><u>DEAD LOAD</u></p> <p><math>s = 0.3(1.0)(25) = 7.5 \text{ kN/m}</math></p> <p><math>M_{max} = (7.5)(4.27)^2 / 8 = 17.09 \text{ kNm}</math></p> <p><math>V_{max}^R \quad \gamma_{f3} = 1.1 \quad \gamma_{fL} = 1.2 \Rightarrow (1.1)(1.2)(17.09) = 22.56 \text{ kNm}</math></p> <p><math>V_{max} = (7.5) \left( \frac{4.27}{2} \right) \left[ \frac{4.27^2 - 0.1^2}{4.27^2} \right] = 15.26 \text{ kN}</math></p> <p><math>V_{max}^L \quad \gamma_{f3} = 1.7 \quad \gamma_{fL} = 1.15 \Rightarrow (1.1)(1.15)(15.26) = 19.33 \text{ kN}</math></p> <p><u>SUPERDEAD LOAD</u></p> <p>fill <math>18 \text{ kN/m}^3</math> max depth = 2.53m.</p> <p><math>s = (2.53)(1.0)(18) = 45.54 \text{ kN/m}</math></p> <p><math>M_{max} = (45.54)(4.27)^2 / 8 = 103.79 \text{ kNm}</math></p> <p><math>V_{max}^R \quad \gamma_{f3} = 1.1 \quad \gamma_{fL} = 1.2 \Rightarrow (1.1)(1.2)(103.79) = 137.6 \text{ kNm}</math></p> <p><math>V_{max} = (45.54) \left( \frac{4.27}{2} \right) \left[ \frac{4.27^2 - 0.1^2}{4.27^2} \right] = 92.67 \text{ kN}</math></p> <p><math>V_{max}^L \quad \gamma_{f3} = 1.7 \quad \gamma_{fL} = 1.2 \Rightarrow (1.1)(1.2)(92.67) = 122.33 \text{ kN}</math></p>	

Knockanurey Bridge

Calcs By

PT

Checked By:

Date:

Aug 85

Job Title EXISTING BRIDGE ASSESSMENTS

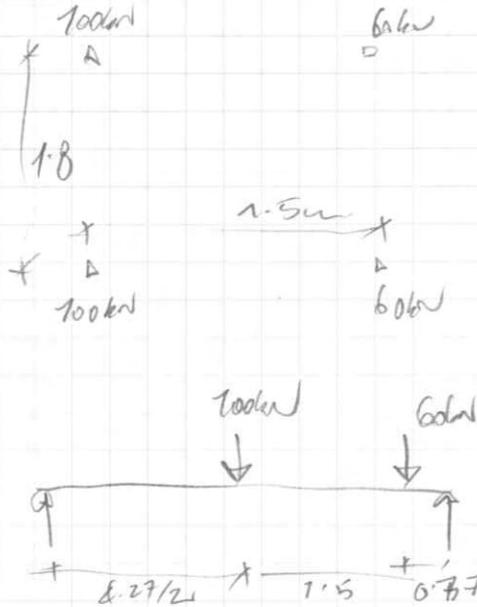
Job No.

04.263

Ref	Calculations	Output
-----	--------------	--------

LIVE LOADING

ACCIDENTAL WHEEL LOADING → B021/01



$$\begin{aligned}
 M_{max} &= (100)(4.27)/4 + 60 \left( \frac{4.27 - 0.77}{4.27} \right) \left( \frac{4.27}{2} \right) - 60(1.5) \\
 &= 127.75 \text{ kNm} / 1.8 \text{ m} \\
 &= 67.64 \text{ kNm}
 \end{aligned}$$

$$M_{max}^{*} \gamma_{f3} = 1.7 \gamma_{fL} = 1.5 \Rightarrow (1.7)(1.5)(67.64) = 171.6 \text{ kNm}$$



$$\begin{aligned}
 V_{max} &= 100 \left( \frac{4.27 - 0.1}{4.27} \right) + 60 \left( \frac{4.27 - 1.6}{4.27} \right) = 136.58 \\
 136.58 / 1.8 &= 75.88 \text{ kN}
 \end{aligned}$$

$$V_{max}^{*} \gamma_{f3} = 1.7 \gamma_{fL} = 1.5 \Rightarrow (1.7)(1.5)(75.88) = 125.20$$



**Roughan & O'Donovan**  
 Consulting Engineers  
 Civil - Structural - Transportation - Environmental

Member/Location

Knockstrawy Bridge

Sheet No.

4

Calcs By

RT

Checked By:

Date:

1 Aug 05

Date:

Job Title EUROPEAN BRIDGE ASSESSMENTS  
TABLE 1

Job No.  
 04.269

Ref	Calculations	Output
	<u>LOAD SUMMARY</u>	
	$M^*$ (kNm)	$V^*$ (kN)
Dead	22.56	79.30
Superload	137.00	122.33
Live	<del>441.60</del>	<del>425.20</del>
Total	<del>271.16</del> 159.56	<del>266.83</del> 141.63

Knockree Bridge

Calcs By

PP

Checked By:

Date: 1

Aug 05

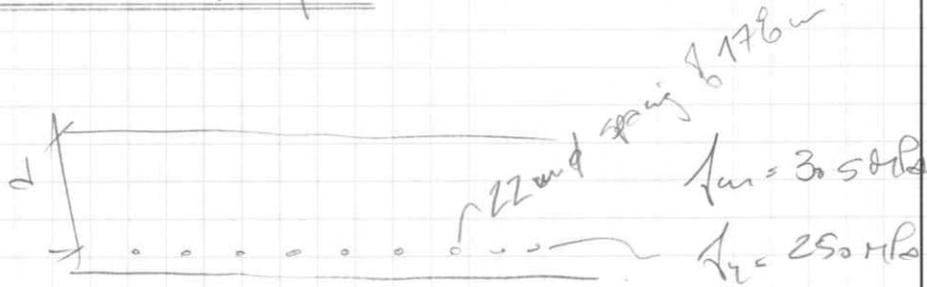
Date:

Job Title *BRIDGE DESIGN*  
 - (PART 1)

Job No.  
 04-269

Ref	Calculations	Output
-----	--------------	--------

Section Analysis



$\gamma_{mc} = 1.2$   
 $\therefore$  check against strength of concrete.

$$d_e = 300 - 35 - 22/2 = 254 \text{ mm} \quad A_s = 2136 \text{ mm}^2$$

$$M_u = M_{ed} \left( \frac{f_y}{\gamma_{ms}} A_s z, 0.225 \frac{f_{cu}}{\gamma_{mc}} b d_e^2 \right)$$

$$\frac{f_y}{\gamma_{ms}} A_s z >$$

$$z = \left[ 1 - \frac{0.8 \frac{f_y}{\gamma_{ms}} A_s}{\frac{f_{cu}}{\gamma_{mc}} b d_e} \right] d_e$$

$$= \left[ 1 - \frac{0.8 \frac{250}{1.05} 2136}{\frac{30.5}{1.2} 1000 \cdot 254} \right] d_e = 0.93 d_e < 0.95 d_e \text{ ok}$$

$$= 237 \text{ mm}$$

$$M_u = \frac{250}{1.05} 2136 \cdot 237 = \underline{\underline{120.6 \text{ kNm}}}$$

$$0.225 \frac{f_{cu}}{\gamma_{mc}} b d_e^2 >$$

$$M_u = (0.225) \frac{30.5}{1.2} (1000)(254)^2 = 368.9 \text{ kNm}$$

$$M_u = 120.6 \text{ kNm}$$

Knokeavran Bridge

Calcs By

J

Checked By:

Date:

Aug '05

Date:

Job Title EUROPEAN BRIDGE ASSESSMENT

Job No.  
04.269

Ref	Calculations	Output
	$\frac{\{S_d\}}{\{R_d\}} = \frac{159.56}{277.16} \cdot 1.32 = 2.25 > 1.0 \rightarrow \text{fail}$ <p>(without accidental wheel load <math>S_d/R_d = 1.32</math> fail)</p> <p>Check shear capacity:</p> <p>No effective shear reinforcement</p> $\Rightarrow V_u = \sum V_c b_w d$ $\sum V_c = \left(\frac{550}{d}\right)^{1/4} = \left(\frac{550}{254}\right)^{1/4} = 1.213$ $V_c = \frac{0.24}{\gamma_{mv}} \left(\frac{100 A_s}{b_w d}\right)^{1/3} (f_{cu})^{1/4}$ $= \frac{0.24}{1.15} \left(\frac{100 \cdot 2136}{1000 \cdot 254}\right)^{1/3} (30.5)^{1/4}$ $= 0.615 \text{ MPa}$ $\Rightarrow V_u = (1.213)(0.615)(1000)(254) = 189.53 \text{ kN}$ $\frac{\{S_d\}}{\{R_d\}} = \frac{147.63}{266.83} = 1.11 > 1.0 \rightarrow \text{fail}$ <p>(without accidental wheel loading <math>S_d/R_d = 0.74</math> pass)</p>	

MO-N05-013.00 Knockavrony Bridge

Maintaining Agent.....: 23 MO - Mayo  
Road.....: Westport, County Mayo - Longford  
Side of road.....: 0  
Region.....: 1 Connacht\Ulster  
Struct. reg. no.....: 225

Year of construction.....:  
Year of reconstruction.....:  
Primary passage Overbridge/Underbridge: U  
Dir. of chainage on primary road.....: E  
Access equipment needed.....: 0 Nothing

Data collected: Date .....: 15 May 2024  
Inspector Initials....: CS  
Checker Initials.....: CP

MO-N05-013.00 Knockavrony Bridge

Geographical position (ITM):

Easting: 525521.438 Northing: 794149.507

Geometry:

Number of spans.....:	1
Min span length.....(m):	3.40
Max span length.....(m):	3.40
Overall length.....(m):	3.40
Width out-to-out.....(m):	32.30
Width of median.....(m):	0.00
Width of footway left....(m):	2.55
Width of footway right....(m):	0.93
Width of carriageway.....(m):	10.30
Width kerb-to-kerb.....(m):	13.65
Width of approach.....(m):	10.30
Area.....(m2):	109.82
Minimum Parapet Height....(m):	0.20
Width of Soft Verge Left..(m):	8.00
Width of Soft Verge Right.(m):	0
Approach Skew 1.....(deg):	0.00
Approach Skew 2.....(deg):	0.00
Bridge curved.....(Y/N):	N
Skew.....(deg):	45

Span Lengths:

Span 1...(m):	3.46	Span 6...(m):	0	Span 11...(m):	0
Span 2...(m):	0	Span 7...(m):	0	Span 12...(m):	0
Span 3...(m):	0	Span 8...(m):	0	Span 13...(m):	0
Span 4...(m):	0	Span 9...(m):	0	Span 14...(m):	0
Span 5...(m):	0	Span 10...(m):	0		

Superstructure, principal type:

Standard design .....(Y/N):	Y	
Design of cross section.....:	65	Pipe
Design of elevation.....:	43	Pipe Culvert
Material of primary members.....:	50	Corrugated Steel

**MO-N05-013.00 Knockavrony Bridge**

**Superstructure, secondary type (if applicable):**

Standard design .....(Y/N):	Y	
Design of cross section.....:	10	Slab
Design of elevation.....:	10	Simple span, cons. cross sect.
Material of primary members.....:	20	In situ Reinforced Concrete

**Superstructure, tertiary type (if applicable):**

Standard design .....(Y/N):		
Design of cross section.....:	91	Not applicable
Design of elevation.....:	91	Not applicable
Material of primary members.....:	91	Not applicable

**Substructure:**

Abutment: Type.....:	10	Abutm. wall, integ. wing walls
Material.....:	20	Mass concrete
Foundation.....:	10	Spread footing
Pier: Type.....:	91	Not applicable
Material.....:	91	Not applicable
Foundation.....:	91	Not applicable

MO-N05-013.00 Knockavrony Bridge

Details:

Type of parapet.....:	30	Concrete cast in situ
Type of safety barrier.....:	41	Steel barrier on steel posts
Type of wearing surface.....:	23	Hot rolled asphalt
Type of expansion joint.....:	91	Not applicable
Type of fixed bearings on support...:	91	Not applicable
Type of free bearings on support...:	91	Not applicable
Type of fixed bearings on girders...:	91	Not applicable
Type of free bearings on girders...:	91	Not applicable

Obstacle:

Type of passage.....:	31	River
Passage id.....:		RIVER
Passage name.....:		Strade River
Road side.....:		90

Vertical Clearance:

Primary passage.....(m):	L:	LM:	RM:	R:
Secondary passage.....(m):	L: 0.80	LM: 0.80	RM: 0.80	R: 0.80

Miscellaneous:

Design Load.....:		
Load Distribution.....:	1	Distribution in 2 directions
Technical Standards.....:	0	Unknown standard
Assessed Capacity Normal.....:	2	0T GVW
Assessed Capacity Abnormal.....:	2	0 Units HB
Weight Restriction.....:		
Owner:	23	Mayo County Council
Maintaining Agent.....:	23	Mayo County Council
Inspection Consultant.....:	96	Atkins
Designer/Consultant.....:	92	Unknown
Technical installations.....:	5	Telephone installation

**MO-N05-013.00 Knockavrony Bridge**

**Remarks:**

The structure is constructed of a 3.4m dia. corrugated steel pipe extended by an 8m long 3m span reinforced concrete slab. The slab section has a skew of 45 degrees and a skew span of 4m. Type of parapet applies to the north elevation only. Type of guardrail applies to the south verge only. Steel and concrete (1No. of each) inlet pipes cut into the corrugated pipe.

<b>Chronological Overview</b>		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Date	Activity	Br	Ex	Fo	Pa	Em	Wi	Ab	Pi	Be	De	Be	Ri	Ot	St
Remarks															
23 Aug 2012	Principal inspection	2	-	-	2	1	2	1	-	-	1	-	2	0	1
31 Aug 2017	Principal inspection	0	-	-	0	0	0	0	-	-	0	-	1	0	1
04 Mar 2022	Principal inspection	0	-	0	0	0	1	1	-	-	1	-	2	1	1
29 May 2023	Principal inspection	0	-	0	1	1	2	0	-	-	1	-	1	1	1
15 May 2024	Principal inspection	0	-	1	1	1	2	0	-	-	1	-	1	1	1

MO-N05-013.00 Knockavrony Bridge

**Principal Inspection:**

Date.....:	15 May 2024
Team Leader Name.....:	Curtis Swanepoel
Initials.....:	CS
Weather.....:	Sunny
Temperature.....(deg. C):	15
Traffic:Annual Average Daily Traffic.:	8641
Percentage, light vehicles...:	96
Percentage, heavy vehicles...:	4
Year for next Principal Inspection...:	2025

**Remark:**

AADT Information sourced from TII Traffic Counter Data from 'TMU N05 100.0W' in year 2023, based on 99.1% coverage.

**MO-N05-013.00 Knockavrony Bridge**

No	Component  Repair work Damage description Type of damage	Repair Work							
		Con rtg	Mtn req	Spe Ins	T P	Qty	Year	Cost	Pho tos
1	<b>Bridge surface</b>  The bridge surface is in good condition, see P1.1 for a view looking east.	0	N	N					1
2	<b>Expansion joints</b>	-		N					0
3	<b>Footways/median</b>  Both rubbing strips are in good condition, see P3.1 for a view of the north rubbing strip looking east. There is vegetation growth at the base of the south rubbing strip which should be removed during RM, see P3.2.	1	Y	N					2
4	<b>Parapets/Safety barrier</b>  The south safety barrier is in good condition, see P3.2. The north parapet wall has vegetation clearance required during RM, see P4.1.	1	Y	N					1
5	<b>Embankments/Revetments</b>  All embankments are in good condition apart from vegetation growth which should be cut back during RM. See P5.1 for a view of the northwest embankment.	1	Y	N					1
6	<b>Wing/Spandrel/Retaining Walls</b>	2	Y	N					3

**MO-N05-013.00 Knockavrony Bridge**

No	Component	Repair Work							
		Con rtg	Mtn req	Spe Ins	T P	Qty	Year	Cost	Pho tos
	<p>A : Concrete repair (without reinforcement)</p> <p>All wing walls are in good condition apart from vegetation growth which should be removed during RM. See P6.1 for a view of the southeast wing wall. There is a crack and undermining of 400mm at the southwest wing wall that should be repaired during RM, see P6.2 and P6.3 respectively.</p> <p>Erosion / scour</p>				A	1	2027	400	
	<p><b>7 Abutments</b></p> <p>Both concrete abutments are in good condition apart from minor honeycombing and algae stationing which requires no action. See P7.1 and P7.2 for views of the east and west abutments looking south.</p>	0	N	N					2
	<p><b>8 Piers</b></p>	-		N					0
	<p><b>9 Bearings</b></p>	-		N					0
	<p><b>10 Deck/slab/arch barrel</b></p>	1	Y	N					2

MO-N05-013.00 Knockavrony Bridge

No	Component  Repair work Damage description Type of damage	Repair Work							
		Con rtg	Mtn req	Spe Ins	T P	Qty	Year	Cost	Pho tos
	The RC deck extension is in good condition, see P10.1 for a view of the deck looking south. There is spalling to the northwest side of the extension deck that should be repaired during RM, see P10.2. The 2005 Stage 1 Assessment Report indicated that the RC slab structure had no live load capacity. The current inspection showed no evidence of failure of the deck such as appearance of flexural cracks although 15-20mm deflection is noted at midspan in the elevation which appears to be historic and as reported in the previous inspection.								
	<b>11 Beams/girders/transverse beams</b>	-		N					0
	<b>12 Riverbed</b>  The riverbed is in good condition. See P12.1 and P12.2 for views of the upstream (south) and downstream(north) respectively. There is minor honeycombing to the scour protection in the northwest abutment which requires no action, see P7.2.	1	N	N					2
	<b>13 Other elements</b>  The corrugated pipe is in good condition apart from minor corrosion and staining which require no action, see P13.1 for a view looking north.	1	N	N					1
	<b>14 Structure in general</b>	1	Y	N					2

**MO-N05-013.00 Knockavrony Bridge**

<p>The structure is in good condition overall. Minor routine maintenance is required. See P14.1 and P14.2 for views of the north and south elevations of the structure respectively. The inspection of the structure has been undertaken in accordance with the requirements of TII AM-STR-06039 (BD 79) outside of the normal PI schedule due to the 2005 Stage 1 Assessment Report finding that the RC slab structure was substandard with live load capacity of 0 tonnes (structure was assessed as being incapable of sustaining dead load from the embankment above). The expected mode of failure of the RC slab structure would be by yielding of steel at midspan due to bending. No evidence of failure was recorded during this PI inspection. When viewed in elevation there is an obvious permanent deflection of the slab (15-20mm) however this deflection is also visible in the elevation photos in the 2005 SI report and it does not appear that additional deflection has taken place indicating that the deflection is historic and likely to have occurred during construction.</p>								
<b>Total Cost:</b>								<b>400</b>

MO-N05-013.00 Knockavrony Bridge

Component No. 1 Bridge surface

The bridge surface is in good condition, see P1.1 for a view looking east.

Condition/Mainten. 0 / N

**P1.1**



MO-N05-013.00 Knockavrony Bridge

Component No.	3	Footways/median
---------------	---	-----------------

Both rubbing strips are in good condition, see P3.1 for a view of the north rubbing strip looking east. There is vegetation growth at the base of the south rubbing strip which should be removed during RM, see P3.2.

Condition/Mainten. 1 / Y

**P3.1**



MO-N05-013.00 Knockavrony Bridge

Component No.	3	Footways/median
---------------	---	-----------------

Both rubbing strips are in good condition, see P3.1 for a view of the north rubbing strip looking east. There is vegetation growth at the base of the south rubbing strip which should be removed during RM, see P3.2.

Condition/Mainten. 1 / Y



MO-N05-013.00 Knockavrony Bridge

Component No.	4	Parapets/Safety barrier
---------------	---	-------------------------

The south safety barrier is in good condition, see P3.2. The north parapet wall has vegetation clearance required during RM, see P4.1.

Condition/Mainten. 1 / Y

**P4.1**



MO-N05-013.00 Knockavrony Bridge

Component No.	5	Embankments/Revetments
---------------	---	------------------------

All embankments are in good condition apart from vegetation growth which should be cut back during RM. See P5.1 for a view of the northwest embankment.

Condition/Mainten. 1 / Y

**P5.1**



MO-N05-013.00 Knockavrony Bridge

Component No.	6	Wing/Spandrel/Retaining Walls
All wing walls are in good condition apart from vegetation growth which should be removed during RM. See P6.1 for a view of the southeast wing wall. There is a crack and undermining of 400mm at the southwest wing wall that should be repaired during RM, see P6.2 and P6.3 respectively.		
Condition/Mainten.	2	/ Y

**P6.1**



MO-N05-013.00 Knockavrony Bridge

Component No.	6	Wing/Spandrel/Retaining Walls
All wing walls are in good condition apart from vegetation growth which should be removed during RM. See P6.1 for a view of the southeast wing wall. There is a crack and undermining of 400mm at the southwest wing wall that should be repaired during RM, see P6.2 and P6.3 respectively.		
Condition/Mainten.	2	/ Y

**P6.2**



MO-N05-013.00 Knockavrony Bridge

Component No.	6	Wing/Spandrel/Retaining Walls
---------------	---	-------------------------------

All wing walls are in good condition apart from vegetation growth which should be removed during RM. See P6.1 for a view of the southeast wing wall. There is a crack and undermining of 400mm at the southwest wing wall that should be repaired during RM, see P6.2 and P6.3 respectively.

Condition/Mainten.            2 / Y

**P6.3**



15/05/2024

MO-N05-013.00 Knockavrony Bridge

Component No. 7 Abutments

Both concrete abutments are in good condition apart from minor honeycombing and algae stationing which requires no action. See P7.1 and P7.2 for views of the east and west abutments looking south.

Condition/Mainten. 0 / N

**P7.1**



MO-N05-013.00 Knockavrony Bridge

Component No.	7	Abutments
Both concrete abutments are in good condition apart from minor honeycombing and algae stationing which requires no action. See P7.1 and P7.2 for views of the east and west abutments looking south.		
Condition/Mainten.	0	/ N

**P7.2**



MO-N05-013.00 Knockavrony Bridge

Component No.	10	Deck/slab/arch barrel
---------------	----	-----------------------

The RC deck extension is in good condition, see P10.1 for a view of the deck looking south. There is spalling to the northwest side of the extension deck that should be repaired during RM, see P10.2.

The 2005 Stage 1 Assessment Report indicated that the RC slab structure had no live load capacity. The current inspection showed no evidence of failure of the deck such as appearance of flexural cracks although 15-20mm deflection is noted at midspan in the elevation which appears to be historic and as reported in the previous inspection.

Condition/Mainten. 1 / Y

**P10.1**



MO-N05-013.00 Knockavrony Bridge

Component No.	10	Deck/slab/arch barrel
---------------	----	-----------------------

The RC deck extension is in good condition, see P10.1 for a view of the deck looking south. There is spalling to the northwest side of the extension deck that should be repaired during RM, see P10.2.

The 2005 Stage 1 Assessment Report indicated that the RC slab structure had no live load capacity. The current inspection showed no evidence of failure of the deck such as appearance of flexural cracks although 15-20mm deflection is noted at midspan in the elevation which appears to be historic and as reported in the previous inspection.

Condition/Mainten.            1 / Y

**P10.2**



15/05/2024

MO-N05-013.00 Knockavrony Bridge

Component No.	12	Riverbed
---------------	----	----------

The riverbed is in good condition. See P12.1 and P12.2 for views of the upstream(south) and downstream(north) respectively. There is minor honeycombing to the scour protection in the northwest abutment which requires no action, see P7.2.

Condition/Mainten. 1 / N

**P12.1**



MO-N05-013.00 Knockavrony Bridge

Component No.	12	Riverbed
The riverbed is in good condition. See P12.1 and P12.2 for views of the upstream(south) and downstream(north) respectively. There is minor honeycombing to the scour protection in the northwest abutment which requires no action, see P7.2.		
Condition/Mainten.	1	/ N

**P12.2**



MO-N05-013.00 Knockavrony Bridge

Component No.	13	Other elements
---------------	----	----------------

The corrugated pipe is in good condition apart from minor corrosion and staining which require no action, see P13.1 for a view looking north.

Condition/Mainten. 1 / N

**P13.1**



## MO-N05-013.00 Knockavrony Bridge

Component No.	14	Structure in general
<p>The structure is in good condition overall. Minor routine maintenance is required. See P14.1 and P14.2 for views of the north and south elevations of the structure respectively.</p> <p>The inspection of the structure has been undertaken in accordance with the requirements of TII AM-STR-06039 (BD 79) outside of the normal PI schedule due to the 2005 Stage 1 Assessment Report finding that the RC slab structure was substandard with live load capacity of 0 tonnes (structure was assessed as being incapable of sustaining dead load from the embankment above). The expected mode of failure of the RC slab structure would be by yielding of steel at midspan due to bending. No evidence of failure was recorded during this PI inspection. When viewed in elevation there is an obvious permanent deflection of the slab (15-20mm) however this deflection is also visible in the elevation photos in the 2005 SI report and it does not appear that additional deflection has taken place indicating that the deflection is historic and likely to have occurred during construction.</p> <p>Condition/Mainten.            1 / Y</p>		

**P14.1**

MO-N05-013.00 Knockavrony Bridge

Component No.	14	Structure in general
---------------	----	----------------------

The structure is in good condition overall. Minor routine maintenance is required. See P14.1 and P14.2 for views of the north and south elevations of the structure respectively.

The inspection of the structure has been undertaken in accordance with the requirements of TII AM-STR-06039 (BD 79) outside of the normal PI schedule due to the 2005 Stage 1 Assessment Report finding that the RC slab structure was substandard with live load capacity of 0 tonnes (structure was assessed as being incapable of sustaining dead load from the embankment above). The expected mode of failure of the RC slab structure would be by yielding of steel at midspan due to bending. No evidence of failure was recorded during this PI inspection. When viewed in elevation there is an obvious permanent deflection of the slab (15-20mm) however this deflection is also visible in the elevation photos in the 2005 SI report and it does not appear that additional deflection has taken place indicating that the deflection is historic and likely to have occurred during construction.

Condition/Mainten. 1 / Y

**P14.2**



# Appendix B. Results of Additional Literature Search

No additional material found.

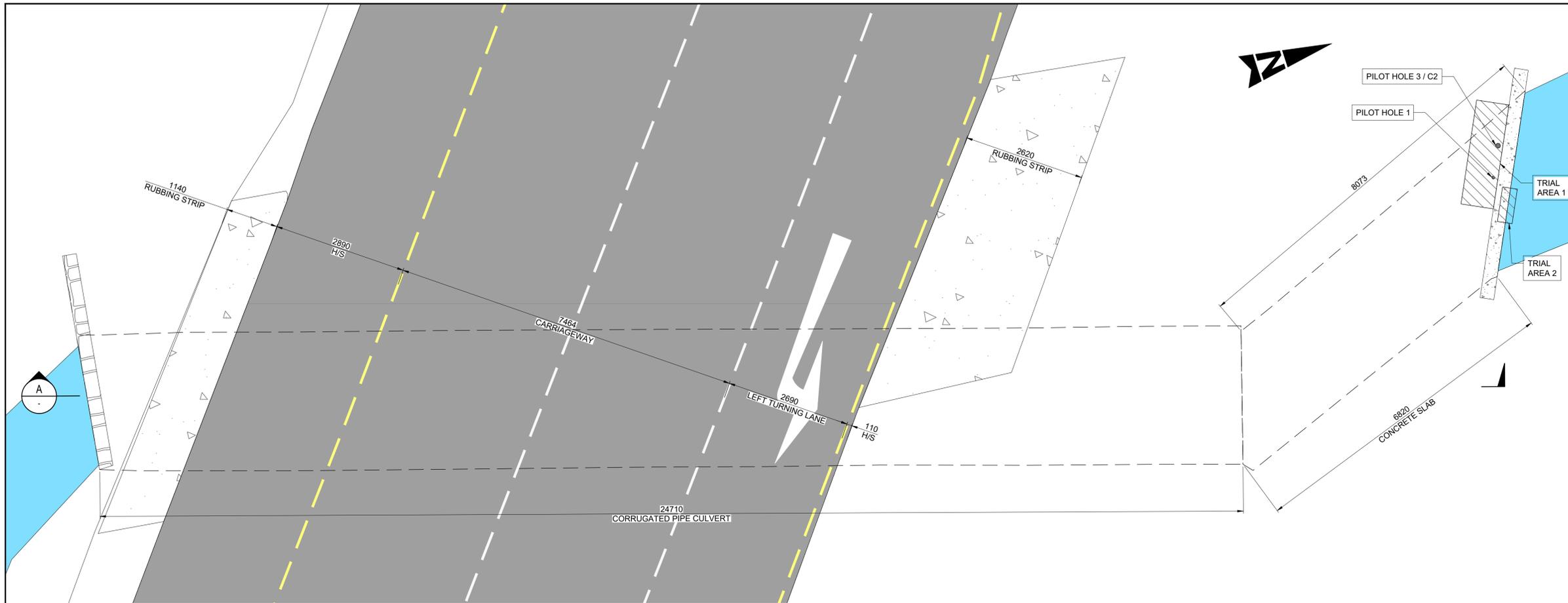


# Appendix C. General Arrangement Drawings

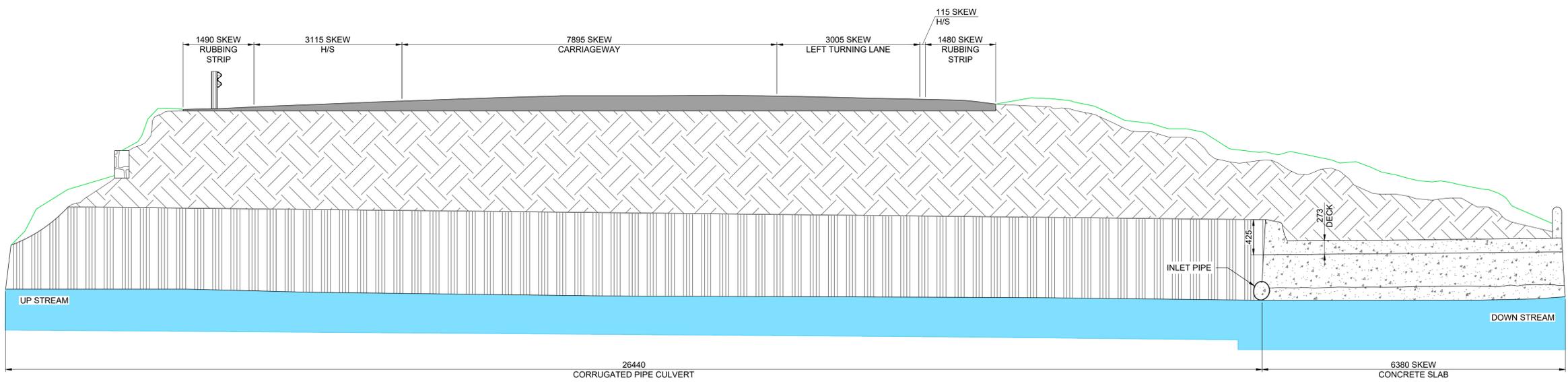


100  
10  
0  
A1

DO NOT SCALE



**PLAN**  
Scale at A1 1:50  
Scale at A3 1:100



**SECTION A**  
Scale at A1 1:50  
Scale at A3 1:100

- GENERAL NOTES**
1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE
  2. ONLY WRITTEN DIMENSIONS SHALL BE USED. NO DIMENSIONS SHALL BE SCALED FROM THE DRAWINGS
  3. ALL LEVELS ARE IN METRES AND ARE TO MALIN HEAD DATUM
  4. ALL COORDINATES ARE IN METRES AND ARE TO IRISH TRANSVERSE MERCATOR
  5. DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE SPECIFICATION

File: 0088572-ATK-01-XX-DR-CE-900201 to 0202.dwg  
Date: Nov 08, 2024 - 10:40am  
Plotted by: obge2

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Rev	Description	By	Date	Chk'd	Rev'd	Auth
PO	ISSUED FOR REVIEW	SOC	08.24	POS	MG	MJ



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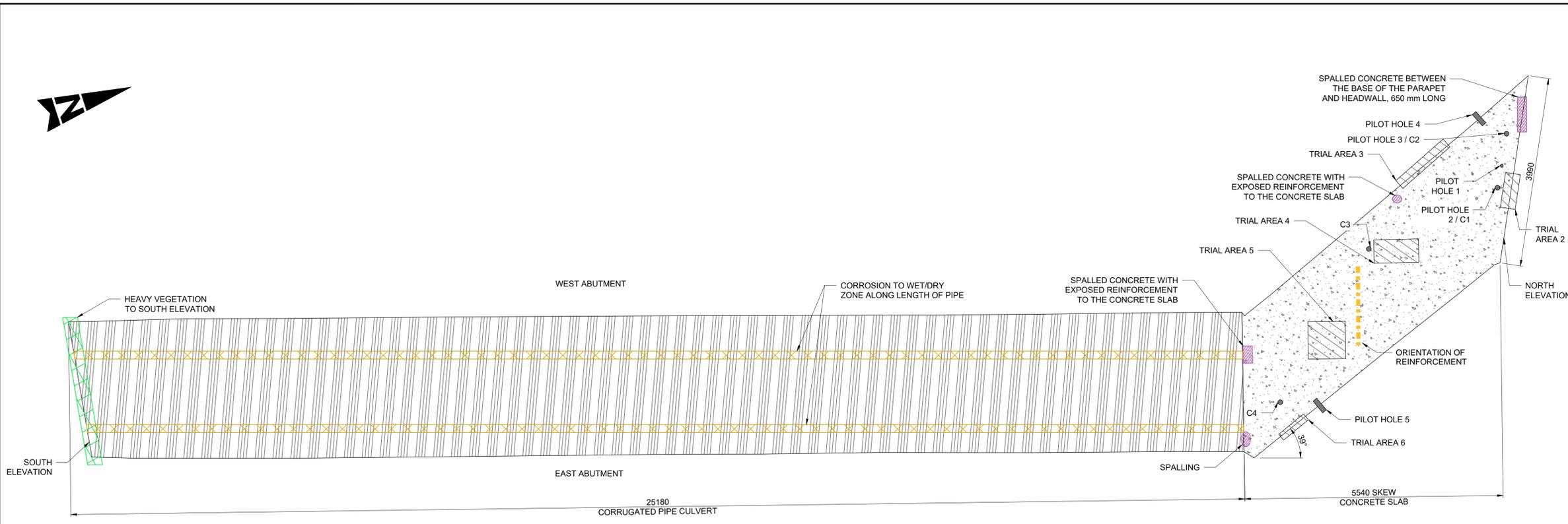
Client: Comhairle Contae Mhaigh Eo Mayo County Council

Project: TO315 - MAYO BRIDGE ASSESSMENTS AND STRENGTHENING 2023

Purpose: PRELIMINARY ISSUE	
Title: Knockavrony Bridge MO-N05-013.00 PLAN AND CROSS SECTION	
Original Scale: 1:50	Drawn: SOC
Date: 30.08.24	Checked: POS
Date: 30.08.24	Revised: MG
Date: 30.08.24	Authorised: MJ
Status: S0	Drawing Number: 0088572-ATK-01-XX-DR-CE-900201
Rev: PO	

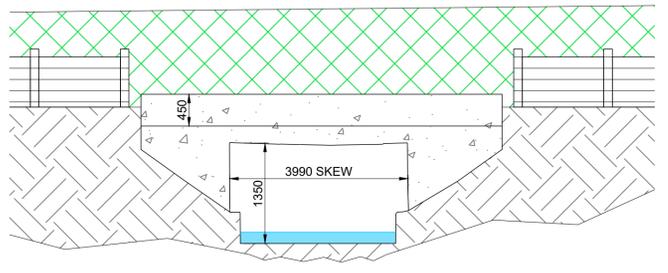
100  
10  
0  
A1

DO NOT SCALE

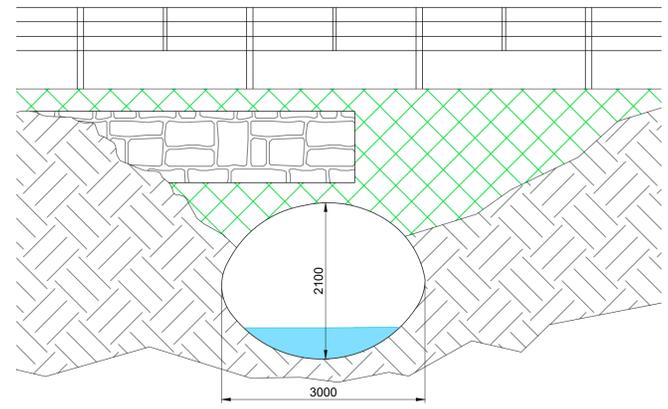


- GENERAL NOTES**
1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE
  2. ONLY WRITTEN DIMENSIONS SHALL BE USED. NO DIMENSIONS SHALL BE SCALED FROM THE DRAWINGS
  3. ALL LEVELS ARE IN METRES AND ARE TO MALIN HEAD DATUM
  4. ALL COORDINATES ARE IN METRES AND ARE TO IRISH TRANSVERSE MERCATOR
  5. DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE SPECIFICATION

**DEFECT PLAN**  
Scale at A1 1:50  
Scale at A3 1:100



**NORTH ELEVATION**  
Scale at A1 1:50  
Scale at A3 1:100



**SOUTH ELEVATION**  
Scale at A1 1:50  
Scale at A3 1:100

Purpose		PRELIMINARY ISSUE							
Title		Knockavrony Bridge MO-N05-013.00 ELEVATIONS AND DEFECT LAYOUT PLAN							
Original Scale	1:50	Drawn	SOC	Checked	POS	Reviewed	MG	Authorised	MJ
Date	30.08.24	Date	30.08.24	Date	30.08.24	Date	30.08.24	Date	30.08.24
Status	S0	Drawing Number	0088572-ATK-01-XX-DR-CE-900202			Rev	P0		

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PO	ISSUED FOR REVIEW	SOC	08.24	POS	MG	MJ
Rev	Description	By	Date	Chk'd	Rev'd	Auth

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TO315 - MAYO BRIDGE ASSESSMENTS AND STRENGTHENING 2023

File: 0088572-ATK-01-XX-DR-CE-900202.dwg  
Date: Nov 08, 2024 - 10:40am  
Plotted by: abpaz

# Appendix D. Structural Condition Drawing

Refer to Appendix C General Arrangement Drawings for the defect plan



# Appendix E. Copy of Materials Testing Report





# Structural Investigation Report

**MO-N05-013.00 - STRUCTURAL INVESTIGATION REPORT  
– [REV3]**

**09<sup>TH</sup> December 2024**

PREPARED FOR



Comhairle Contae Mhaigh Eo  
Mayo County Council



Bonneagar Iompair Éireann  
Transport Infrastructure Ireland



**CONTENTS**

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5.	DETAILED SKETCHES .....	6
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8.	APPENDIX 2 – LAB TEST REPORT	

## 1. INTRODUCTION

TRIUR Construction LTD carried out structural investigation works on Knockavrony Bridge (MO-N05-013.00) on the 5<sup>th</sup> and 8<sup>th</sup> of July 2024.

The Scope of the work included the following:

The site works were to consist of the following:

- Mobilization and site set up
- Installation of traffic management measures
- Digging of access ramp for excavator on northern verge.
- Excavation of the trial pit in the northern verge.
- Coring of 4x samples for strength testing of deck soffit.
- The drilling of pilot holes in both the deck and the abutments, as required.
- Expose the deck slab and cleaning of the deck surface in adhesion test area.
- Carry out waterproofing adhesion test in Test Area 1
- Ferroskan and Concrete breakout of Test area 1-6.
- Chloride, cement content and carbonation samples obtained for BHP to lab test.
- Half-cell potential and Resisitivity testing conducted by BHP.
- Detailed sketches made of breakout areas to include reinforcement sizing, location, spacing and cover.
- Reinstatement of the breakout and coring areas using PLANITOP RASA AND RIPARA R4 cementitious mortar.
- Reinstatement of any road openings as per *Guidelines for Managing Openings in Public Roads (Guidelines on the Opening, Backfilling and Reinstatement of Openings in Public Roads) Second Edition Rev 1 (2017)*.
- Preparation of a detailed factual report on the investigation work undertaken at each bridge, i.e. one no. report required per bridge
- Removal of traffic management measures
- Demobilization
- The Bridge was reinstated on the 10<sup>th</sup> July 2024
- A detailed sketch was prepared, see below.
- A digital photographic record was carried out throughout the investigation works, see below.

## 2. GENERAL DESCRIPTION OF STRUCTURE

The Knockavrony Bridge is a Single span reinforced concrete deck slab at the north elevation extended south by a corrugated steel pipe which carries the carriageway. It carries the N5 national primary road over a minor stream flowing from south to north.

### Location

**Knockavrony Bridge**

**Co-ordinates: 53.891417, -9.133056**

**MO-N05-013.00, about 1.4km east of Ballyvary**



## 3. INVESTIGATION WORKS

- The excavation of the deck comprised of the removal of fill from a 2m x 2m area to provide sufficient room for testing. No waterproofing was found above the deck surface. No services were found in the excavated area around Test Area 1.
- Reinforcement was found via breakouts in both the deck and in the soffit. Members broken out in the soffit were running at approx. 45 degrees to the abutments. No reinforcement was found from the breakouts in the abutments or the fascia.
- The excavation of a Trial Pit 01 (Test Area 01), located in the grass verge above the RC slab for depth of fill and deck exposure. In this Trial Pit, a Covermeter and GPR survey was conducted to an area of the deck surface followed by concrete breakout to confirm cover and sizing of reinforcement members. The material covering this RC slab was observed to be clay fill. Breakout occurred in a 400mm x 400mm square of the deck surface to expose reinforcement members and carry out durability testing.
- The investigation of Test Area 02 located on the Northern fascia. The test area was first scanned to reveal potential reinforcement. Following this, an area 80mm high x 200mm long x 200mm deep was then broken out in an attempt to inspect reinforcement. However, it was not possible to determine reinforcement details from the fascia as no steel was found in Test Area 02.
- The investigation of Test Area 03 located in the western abutment approx. 2m in from the northern parapet. In this Test area a covermeter and GPR survey was conducted. This was followed by a breakout which did not reveal any reinforcement at a depth of 150mm. The breakout was conducted in an area 380mm x 300mm. A pilot hole was also drilled using a 50 mm diameter core drill to a depth of 975mm in the western abutment beside the breakout
- The investigation of Test Area 04, located in the soffit on the western side at approx. 2m in from the northern parapet. In this area, a Covermeter and GPR survey was conducted. This was followed by a breakout to sufficiently inspect the Reinforcement.
- The investigation of Test Area 05 located in the soffit on the eastern side at approx. 4m in from the

northern parapet. In this area, a Covermeter and GPR survey was conducted. This was followed by a breakout to sufficiently inspect the Reinforcement.

- Test Area 6 on the western abutment 5m from the northern parapet with a pilot hole 860mm deep
- Adhesion pull off test on the deck top surface in Test Area 1 to determine the suitability of deck to a spray applied deck waterproofing system.
- 3no. 100mm diameter concrete cores extracted from the soffit to determine concrete strength (TEST AREA 1).
- 3no. pilot holes in the deck to determine the depth of the deck across the structure at 290mm, 270mm and 260mm. (Photos below).

**4. INVESTIGATION RESULTS**

TEST AREA 1	mm
DECK	
cover of fill	500
cover on longitudinal bars	38
cover on transverse bars	52
Longitudinal bar sizing/mean spacing	16/200
Transverse bar sizing/mean spacing	16/220
pilot hole 1	290
pilot hole 2	270
pilot hole 3	260
Core 1 – Area 1 – Deck	46.6N/mm <sup>2</sup>
Core 2 – Area 1	52.2N/mm <sup>2</sup>

TEST AREA 2	mm
FACIA (north)	
cover of fill	n/a
cover on longitudinal bars	n/a
cover on transverse bars	n/a
Longitudinal bar sizing	n/a
Transverse bar sizing	n/a
<i>No reinforcement found</i>	

<b>TEST AREA 3</b>	<b>mm</b>
Abutment (West)	
cover of fill	n/a
cover on longitudinal bars	n/a
cover on transverse bars	n/a
Longitudinal bar sizing	n/a
Transverse bar sizing	n/a
Pilot hole 4	960
<i>No reinforcement found</i>	

<b>TEST AREA 4</b>	<b>mm</b>
Soffit (north)	
cover of fill	n/a
cover on longitudinal bars	47
cover on transverse bars	n/a
Longitudinal bar sizing/mean spacing	22/180
Transverse bar sizing	n/a
Core 3 – Area 4	53.7N/mm <sup>2</sup>

<b>TEST AREA 5</b>	<b>mm</b>
Soffit (south)	
cover of fill	n/a
cover on longitudinal bars	45
cover on transverse bars	n/a
Longitudinal bar sizing/mean spacing	22/180
Transverse bar sizing	n/a
Core 4 – Area 5 - Core length 270mm (deck Thickness)	49.0 N/mm <sup>2</sup>

<b>TEST AREA 6</b>	<b>mm</b>
Abutment (East)	
cover of fill	n/a
cover on longitudinal bars	n/a
cover on transverse bars	n/a
Longitudinal bar sizing	n/a
Transverse bar sizing	n/a
Pilot hole 5	860

5. DETAILED SKETCHES

Plan of works area – Test Area locations – See appendix 1 for more details.

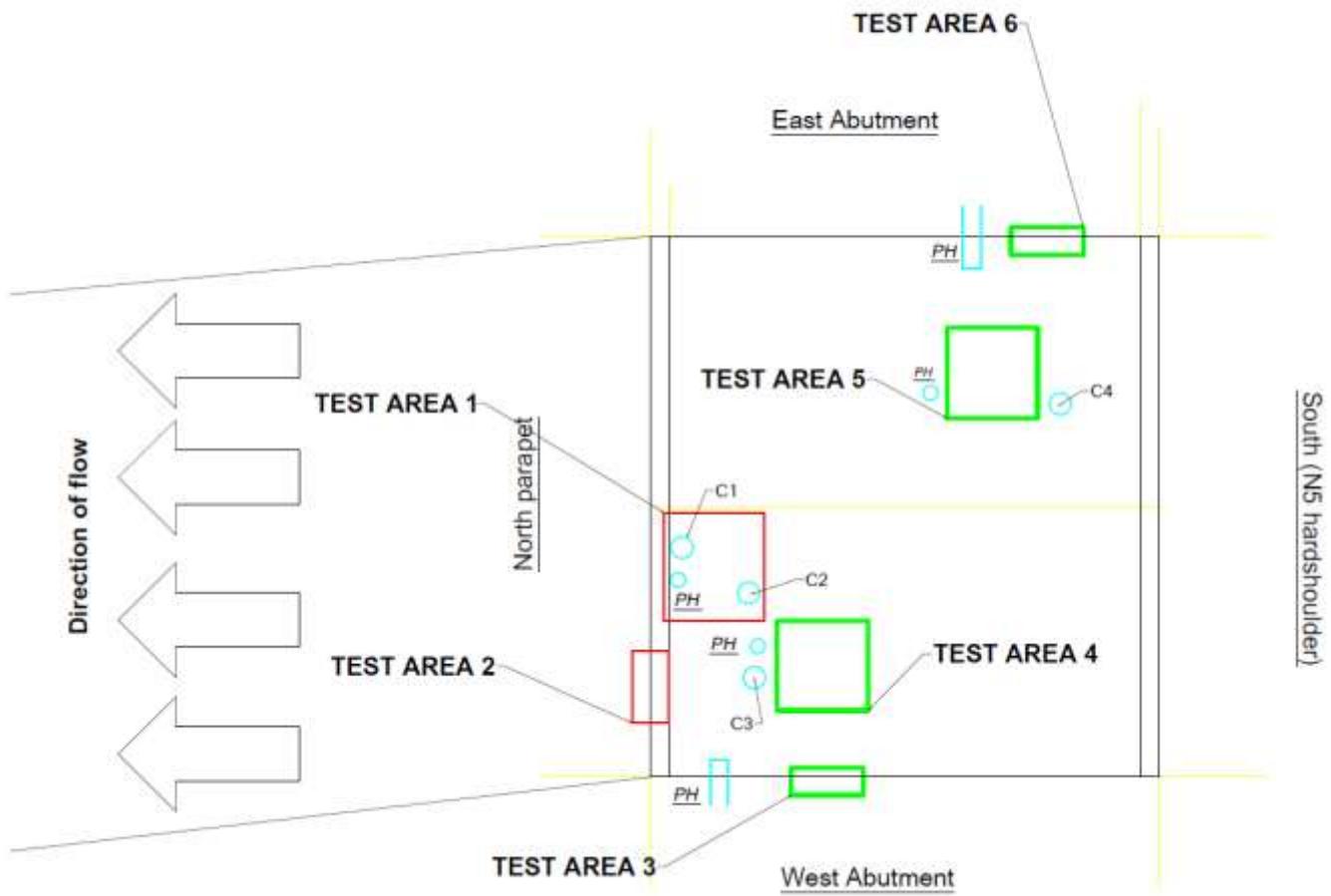


Figure 1: plan of works

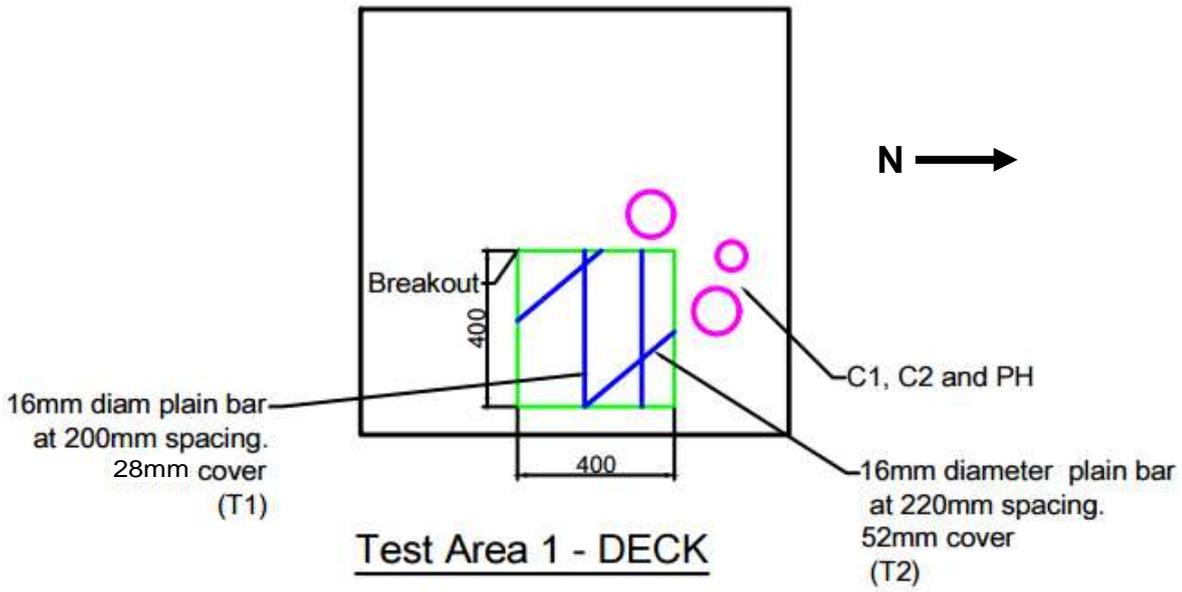
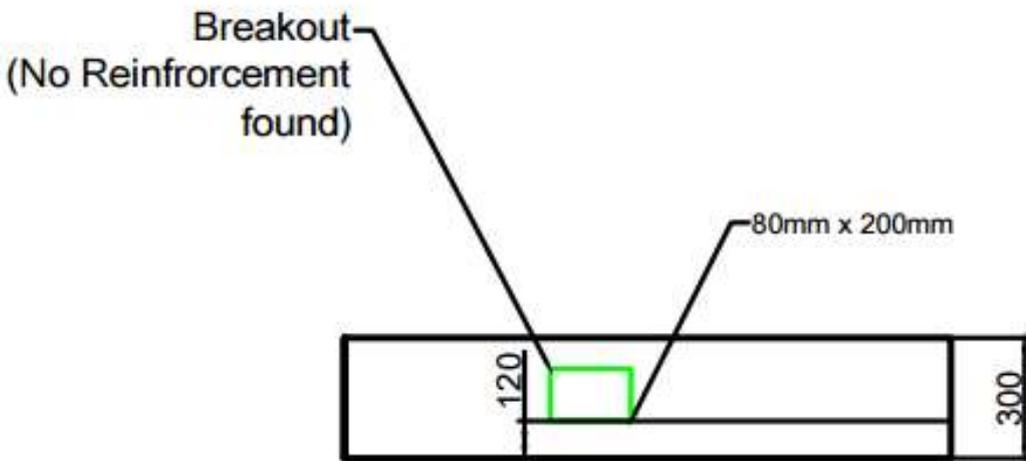


Figure 2: Deck



**Test Area 2 - FACIA**

Figure 3: Facia

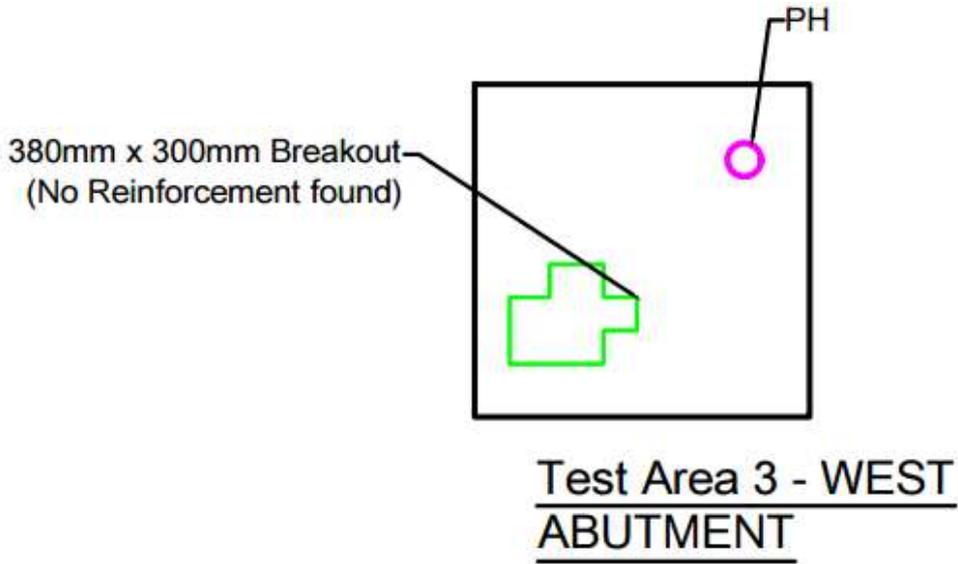


Figure 4: Facia

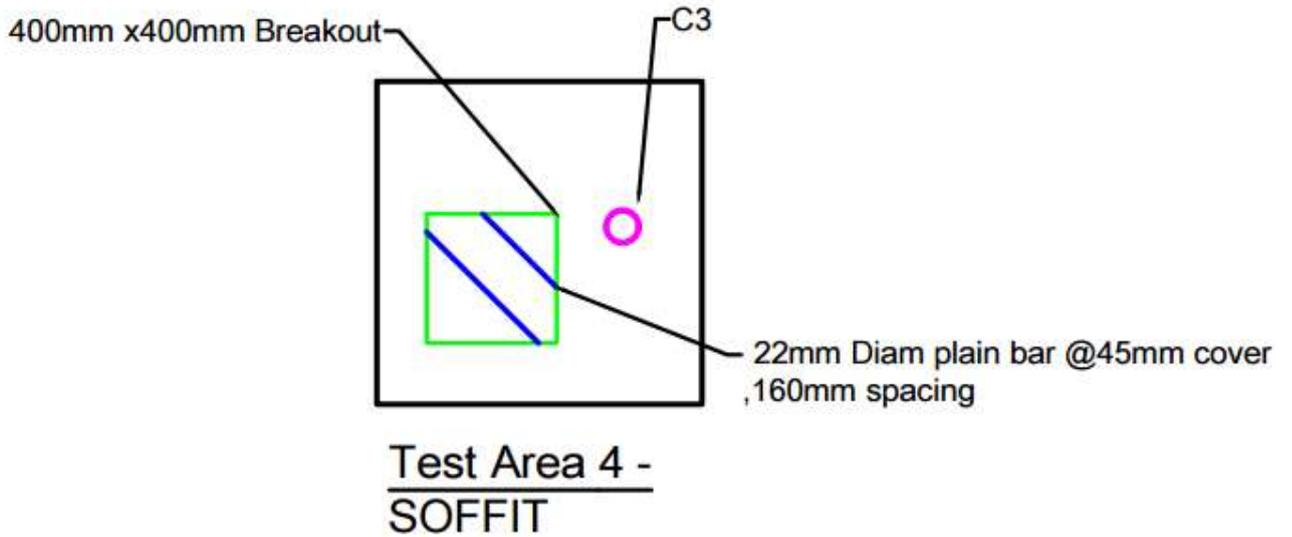


Figure 5: Soffit

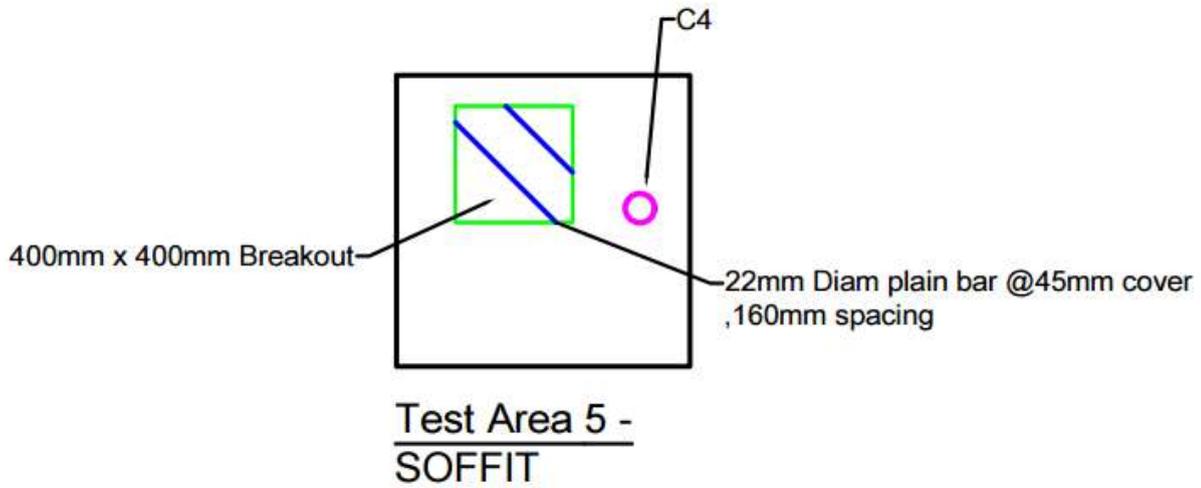


Figure 6: Soffit

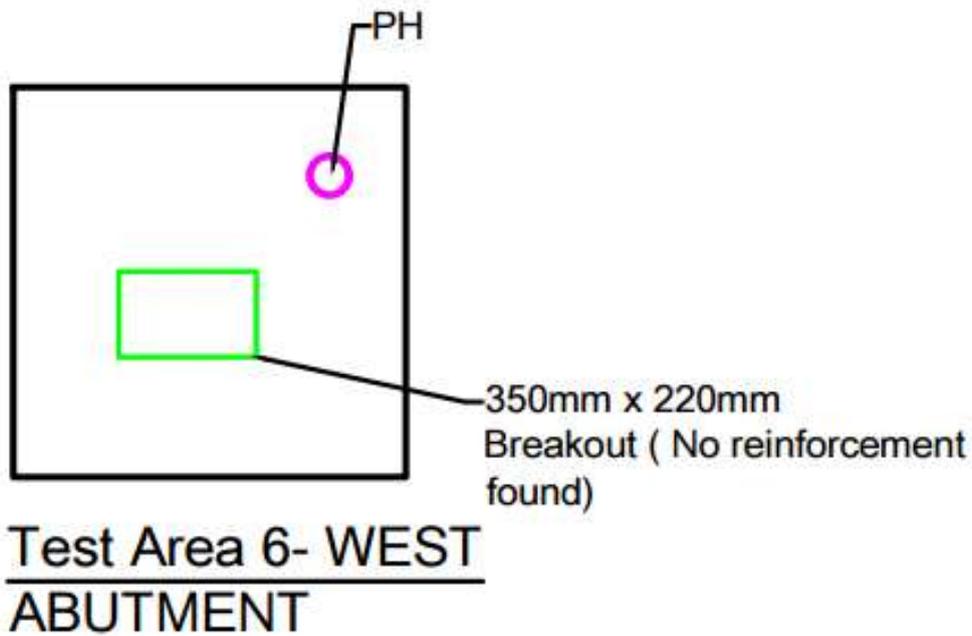


Figure 7: Abutment

6. REINSTATEMENT PHOTOS

**Only concrete reinstatement required at this location.**

**Fosroc Renderoc HB45 was used to carry out concrete repairs to breakouts**



## 7. PHOTO REPORT

### General bridge overview





**Test Area 1**



*Figure 8: Pilot hole 25mm drill bit*



*Figure 9: Depth of fill in verge*



Figure 10: Ferro scan and adhesion test



*Figure 11: Top Reinforcement of Deck Slab*



*Figure 12: Top Reinforcement of Deck Slab*



*Figure 13: Breakout and Core hole reinstatement*

**Test Area 2**



*Figure 14: Breakout of the Northern Facia revealing no reinforcement at a depth of 200mm approx.*

**Test Area 3**



*Figure 15: West abutment showing breakout and 50mm diameter pilot hole*



Figure 16: Pilot hole no 4 in Abutment

**Test Area 4**



Figure 17 : Test Area 4 showing breakout with 22mm bars at 160mm spacing, Core to the right



*Figure 18: Test Area 4 Reinforcement Spacing and Location*



*Figure 19 : Measurement of reinforcement members*



*Figure 20: Wetting of test area for the saturation Half Cell and resistivity testing*



*Figure 21: Half-cell testing*

**Test Area 5**



*Figure 22 : Test area 5 Breakout and reinforcement*



*Figure 23 : Test area 5 member spacing and location*



*Figure 24: Sizing of member in Test Area 5*

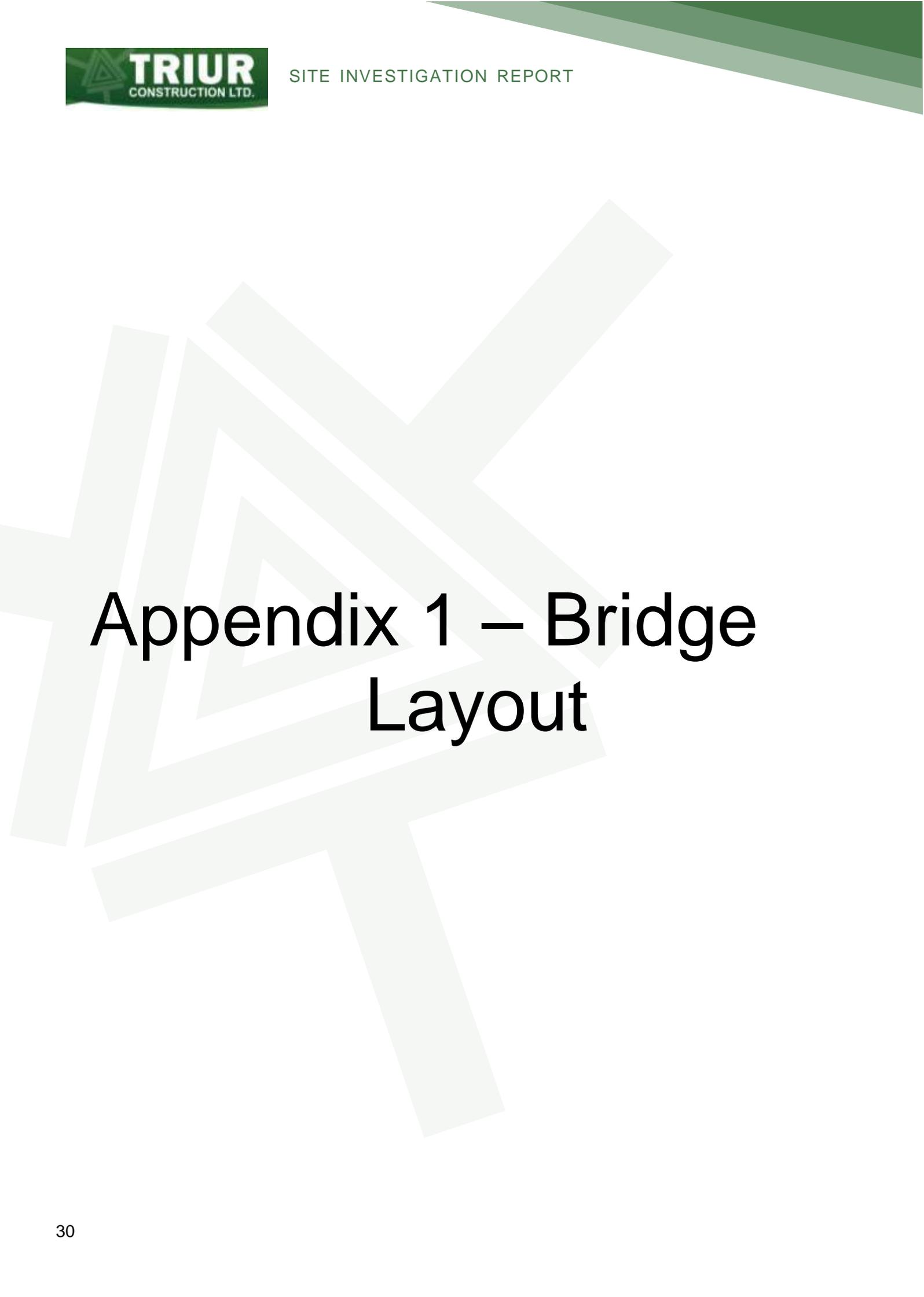
**Test Area 6**



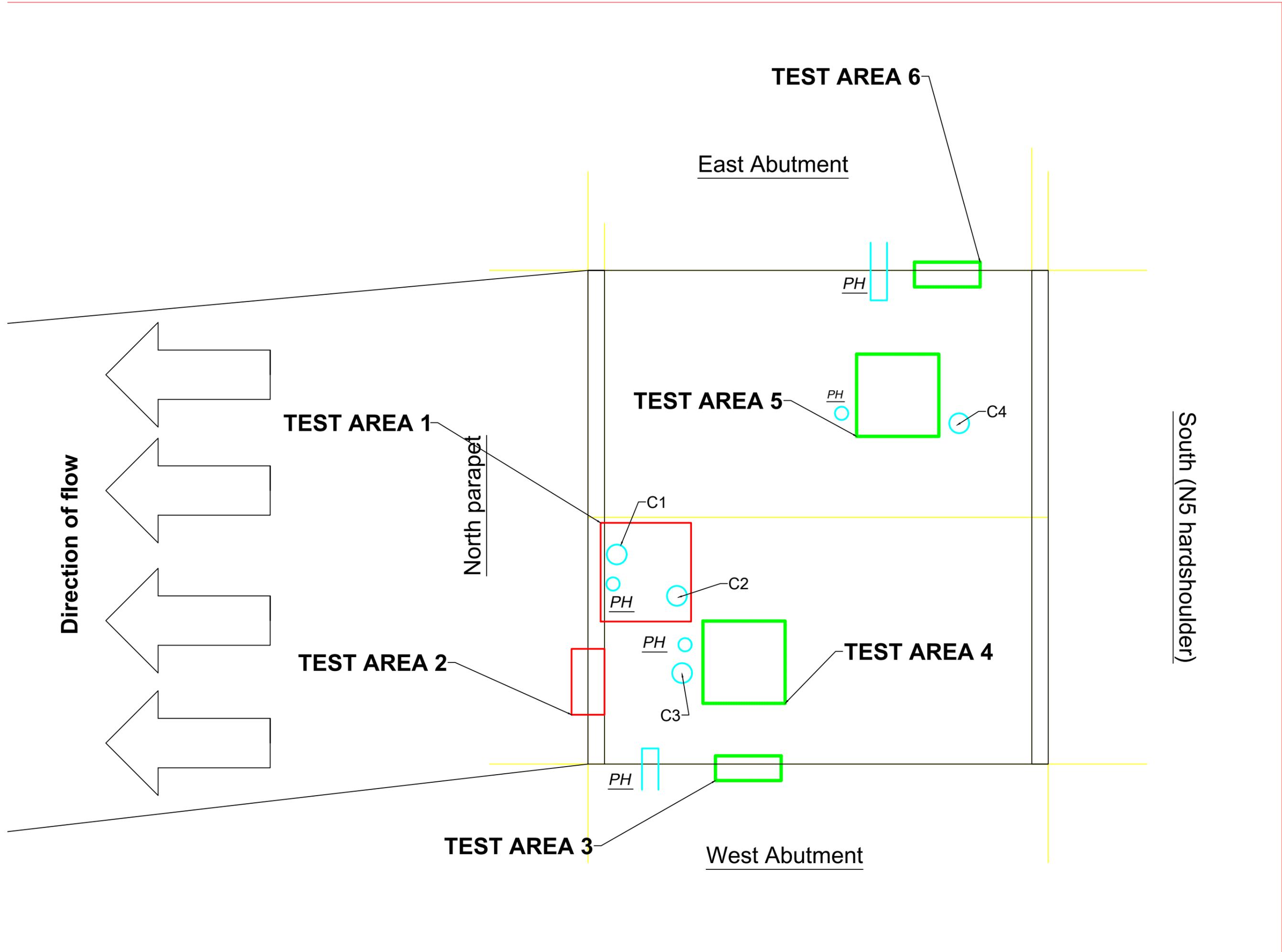
*Figure 25: Test Area 6 breakout*

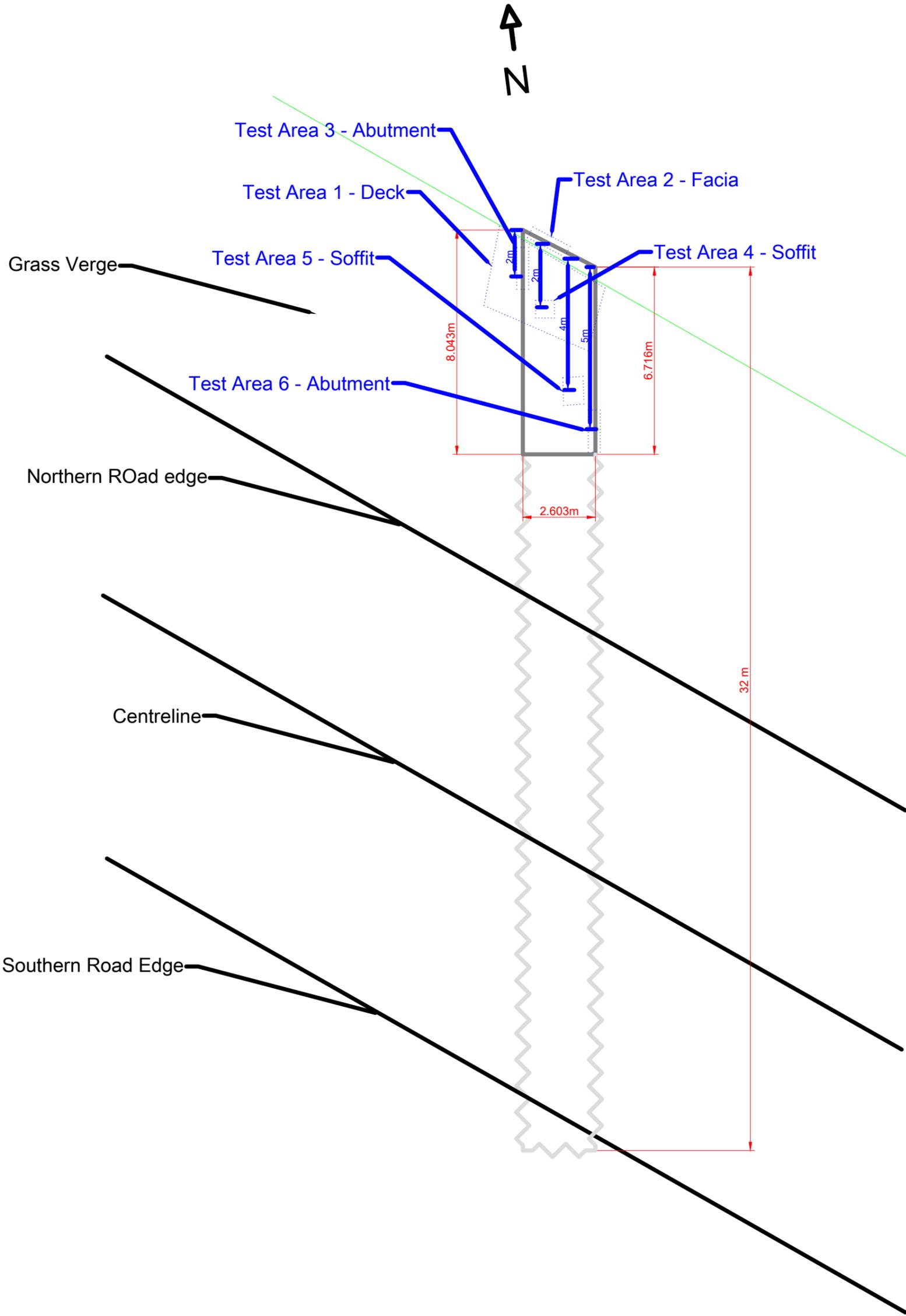


*Figure 26: Wide angle view showing reinstated pilot hole and breakout*

A large, faint, light-green graphic of a bridge layout is centered on the page. It consists of several thick, parallel lines that form a complex, multi-span bridge structure with various angles and supports.

# Appendix 1 – Bridge Layout







Test Area 3 - Abutment

Test Area 1 - Deck

Test Area 2 - Facia

Grass Verge

Test Area 5 - Soffit

Test Area 4 - Soffit

Test Area 6 - Abutment

8.043m

6.716m

2.603m

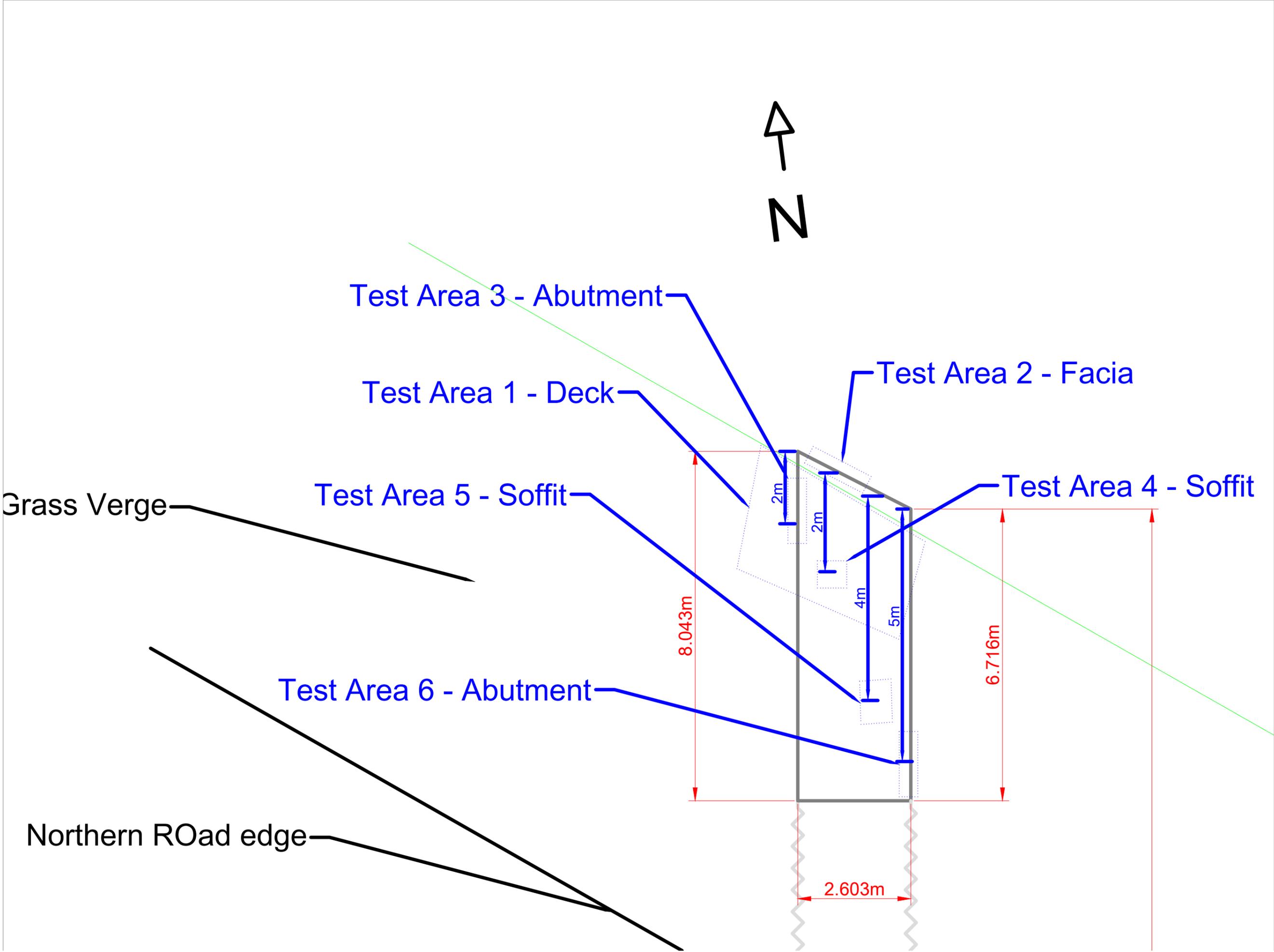
2m

2m

4m

5m

Northern ROad edge



# Appendix 2 – Lab Test report

**Mayo Bridges Inspection –  
Knockavrony Bridge**

**Concrete Testing Report**

**2024**

## Document Issue Register

<b>Distribution</b>	<b>Report Status</b>	<b>Revision</b>	<b>Date of Issue</b>	<b>Prepared by</b>	<b>Approved by</b>
Lurcan Donnellan Triur Construction	Final	A	12 <sup>th</sup> August 2024	Lukasz Zalewski	James Purcell 

## **Contents**

<b>1.0</b>	<b>Project Overview</b>	<b>Page 4</b>
<b>2.0</b>	<b>Project Requirements</b>	<b>Page 4</b>
<b>3.0</b>	<b>Location of Works</b>	<b>Page 5</b>
<b>4.0</b>	<b>Summary of Results</b>	<b>Page 6 – 9</b>

## 1.0 Project Overview

BHP was contracted by Lurcan Donnellan of Triur Construction to provide a survey of the concrete bridge.

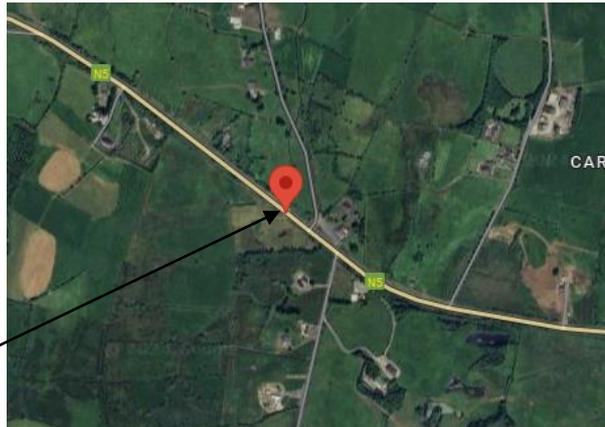
The investigation is intended to provide information for the employer in respect of the structural condition of the concrete deck and parapets and to assess the existing condition to enable evaluation of the proposed need for strengthening/rehabilitation works.

## 2.0 Project Requirements

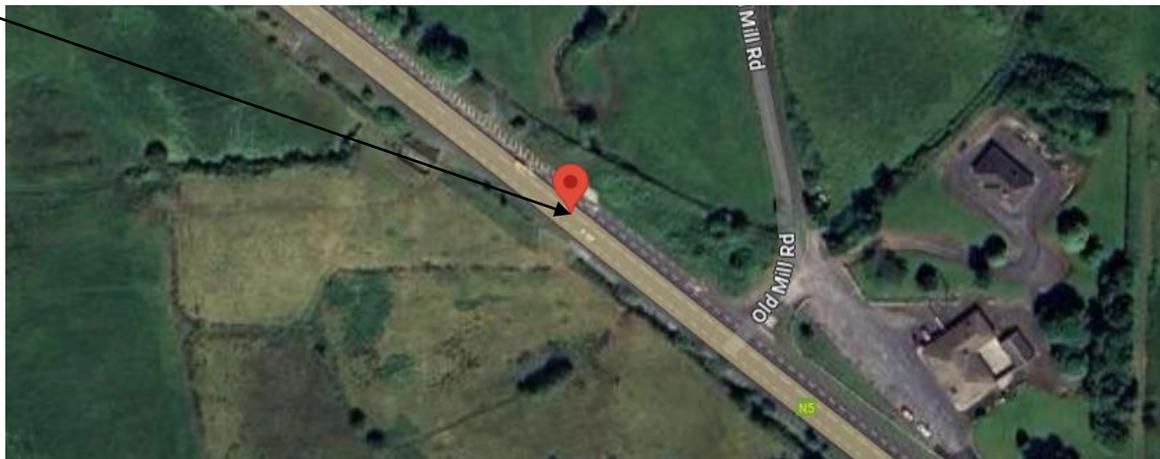
As directed by the project specification the requirements of the works included:

- Drill 4No. 100 diameter cores.
- Test for Density, Compressive strength and Visual examination.
- Chemical testing including chloride ingress, cement content and depth of carbonation.
- 1No. Pull off testing on the concrete deck.
- Reinforcement scanning of concrete deck and parapets.
- Half-cell potential and concrete resistivity.

## 3.0 Location of Works



Site Location /  
Works Area



#### 4.0 Summary of Results

##### 4.1 Concrete Cores – Compressive Strength

In line with the project specification, BHP removed a number of cores from the reinforced concrete elements. These were cored using a water-cooled diamond drill. The cores were individually marked and placed in sealed plastic bags for transportation to the laboratory.

The concrete cores were visually assessed by BHP’s technical manager Seamus O’Connell.

A summary of the results with photographs is contained below:

<b>BHP Ref:</b>	<b>Core Ref.</b>	<b>Details</b>	<b>Density kg/m<sup>3</sup></b>	<b>Compressive Strength N/mm<sup>2</sup></b>
24/07/055-1	Core 1 – Area 1 – Deck	25mm Crushed Rock, 0.5% Voids	2350	46.6
24/07/055-2	Core 2 – Area 1 – Deck	20mm Crushed Rock, 0.5% Voids	2350	52.2
24/07/055-3	Core 3 – Area 2 - Soffit	20mm Crushed Rock, 0.5% Voids	2330	53.7
24/07/055-4	Core 4 – Area 5 - Soffit	20mm Crushed Rock, 0.5% Voids	2290	49.0

#### 4.2 Pull Off Test

In accordance with the project specification, the pull off test was to be performed at one location in the concrete deck.

A summary of the results is contained below with full reports contained in Appendix B of this report.

Test Reference	Max Applied Load (MPa)	Depth of failure (mm)	Failure occurred in
Area 1 top deck	1.2	3	Below adhesive on top of substrate
Area 1 top deck	1.1	2	Below adhesive on top of substrate
Area 1 top deck	0.9	1	Below adhesive on top of substrate
Area 1 top deck	0.8	0	Below adhesive on top of substrate
Area 1 top deck	1.4	2	Below adhesive on top of substrate
<b>Mean</b>	<b>1.08</b>		

### 4.3 Carbonation

In accordance with the project specification, the carbonation testing was to be performed at three locations.

Carbonation testing is carried out to determine the depth of concrete affected due to a combined attack of atmospheric carbon dioxide and moisture causing a reduction in the level of alkalinity in concrete. Cement paste has a pH of approximately 13 which provides a protective layer (passive coating) to the steel reinforcement against corrosion. Loss of passivity occurs at about pH 9.

A 3% phenolphthalein indicator is used for the test. This is applied to freshly exposed concrete surface as detailed above.

Once the indicator is applied to the concrete surface, the change of colour of concrete to pink indicates that the concrete is in good health/condition. Where no change in colour takes place, it is suggestive of carbonation-affected concrete.

The results of the tests performed at Knockavrony Bridge, Co. Mayo are contained in Appendix C of this report.

A summary of the results is contained below:

Location	Depth of Carbonation (mm)	Reinforcement Note
Carbonation Test 1 – Area 1 Deck	<1	N/A
Carbonation Test 2 – Area 1 Deck	<1	N/A
Carbonation Test 3 – Area 5 Soffit	10	N/A
Carbonation Test 4 – Area 2	<1	N/A
Carbonation Test 5 – Area 3 West abutment	<1	N/A
Carbonation Test 6 – Area 4 Soffit	<1	N/A
Carbonation Test 7 – Area 5	17	N/A
Carbonation Test 8 – Area 6 East abutment	24	N/A

#### 4.4 Reinforcement Details

In following pages a summary of reinforcement investigation on deck, parapet sections and information on the reinforcement found in breakouts have been compiled from the survey conducted in Knockavrony Bridge, Co. Mayo

Full details are in Appendix D of this report.

Location	Mean Cover	Mean Spacing
Area 5 Soffit transverse scan	80	266
Area 5 Soffit transverse scan	63	303
Area 5 Soffit longitudinal scan	37	277
	269	234
Area 5 Soffit longitudinal scan	61	310
Area 4 Soffit transverse scan	65	290
Area 4 Soffit transverse scan	65	290
Area 4 Soffit longitudinal scan	52	273
	347	202
Area 4 Soffit longitudinal scan	55	256
	333	220
East abutment vertical scan	0	0
East abutment vertical scan	131	250
East abutment horizontal scan	0	0
East abutment horizontal scan	201	0
West abutment horizontal scan	0	0
West abutment vertical scan	282	0
West abutment vertical scan	197	170
Deck transverse scan	94	365
West abutment horizontal scan	0	0
Deck transverse scan	96	90
Deck longitudinal scan	50	250
Deck longitudinal scan	60	237

Note: Deck soffit reinforcement spacings taken square to abutments not in direction of reinforcement. No transverse reinforcement present in the bottom of the slab, only longitudinal reinforcement present. Both transverse and longitudinal reinforcement present in top of the slab

Reinforcement found by completing a breakout	Actual cover (mm)	Diameter (mm)
Longitudinal bars	40, 45	22
Area 5 soffit 2	50, 45	22

## 4.5 Chloride Ion Testing

Corrosion of reinforcing steel and other embedded metals is the leading cause of deterioration in concrete. When steel corrodes, the resulting rust occupies a greater volume than the steel. This expansion creates tensile stresses in the concrete, which can eventually cause cracking, delamination and spalling.

Steel corrodes because it is not a naturally occurring material. Rather, iron ore is smelted and refined to produce steel. The production steps that transform iron ore into steel add energy to the metal. Steel, like most metals except gold and platinum, is thermodynamically unstable under normal atmospheric conditions and will release energy and revert back to its natural state – iron oxide, or rust. This process is called corrosion.

Corrosion is an electrochemical process involving the flow of charges (electrons and ions). At active sites on the reinforcement bar, called anodes, iron atoms lose electrons and move into the surrounding concrete as ferrous ions. This process is called a half-cell oxidation reaction, or anodic reaction.

Corrosion of embedded metals in concrete can be greatly reduced by placing crack-free concrete with low permeability and sufficient concrete cover. Additional measures to mitigate corrosion of steel reinforcement in concrete include the use of corrosion inhibiting admixtures, coating of reinforcement, and the use of sealers and membranes on the concrete surface.

As noted in section 4.3 carbonation, the breakdown in the protection of reinforcement bars leads to concrete spalling. The depth of carbonation provides a guide as to the risk of corrosion on a particular bar. Concrete that is not carbonated (or has very low levels of carbonation) protects the embedded steel reinforcement.

Exposure of reinforced concrete to chloride ions is the primary cause of premature corrosion of steel reinforcement. The intrusion of chloride ions present in deicing salts, seawater and other associated sources, into reinforced concrete can cause steel corrosion if oxygen and moisture are available to sustain the reaction. Chlorides dissolved in water can penetrate through sound concrete or reach the steel through cracks.

No other contaminant is documented as extensively in the literature as a cause of corrosion of metals in concrete than chloride ions. The risk of corrosion increases as the chloride content of concrete increases. For Knockavrony bridge, Co. Mayo, the major concern is the extent of any existing chloride within the various concrete structural elements. While the levels are assessed during this survey, as the concrete is continually exposed to the natural environments and weathering, the level of chloride in the concrete could increase with time.

To assess potentially chloride-contaminated concrete, it is necessary to determine the concentration of chloride ions at various depths in order to determine the likelihood of corrosion of the reinforcement steel. To do this dust samples are taken from incremental depths. As specified, this was to be carried out in four depths (5-30mm, 30-55mm, 55-80mm & 80-105mm). Note the first 5mm drilling are normally discarded as being non-representative. Care was taken to ensure all drilling dust was collected. This is important as studies have shown that more chloride is contained in the finer component of the dust.

In line with the Irish concrete standard (EN 206), the chloride content as a percentage of cement is to be below the maximum allowable of 0.4% for concrete mixes containing embedded steel. At all six locations, the chloride content as a percentage of cement is well below this value.

#### 4.6 Cement Content

The determination of the cement content (mix proportions) is undertaken largely for two reasons. The first is in the cases of problems to identify the reason for concrete failure or lack of quality. The second is to investigate old structural concrete for redevelopment and improvement works. This is the case in this project. The cement content analysis will also allow BHP to provide chloride and sulphate results as a percentage of cement for clear comparison with standard allowances.

We start by describing the raw materials that go into mortar and concrete and by defining some terms. Cement is a generic term meaning “glue.” Portland cement is a gray powder that when mixed with water forms a paste that hardens and gains strength with time. This is the glue that holds mortar and concrete together. When sand or fine aggregate is added to paste the mixture is known as mortar which is suitable for thin cross sections. Grouts, plasters and stuccos are generally special mortars and contain much the same raw materials. Stone added to mortar makes concrete which can be used in structural or massive applications.

The cement most often used in construction is known as Portland cement. There are other types of construction cements, some used in masonry construction and other special cements used for repairs or high temperature applications. This paper addresses Portland cement and its derivatives only. The predominant chemical compounds in Portland cement are based upon oxides of calcium (lime), silicon (silica), aluminium (alumina) and iron. There are other compounds present in smaller quantities such as magnesia and carbon dioxide and a number of trace elements. The principal chemical compounds that combine with water (hydrate) to provide strength are calcium silicates. However, in all reported chemical analyses, the constituents of cement and concrete are reported simply as the appropriate oxides. Modern Portland cements, by definition, all tend to contain these compounds in a fairly tight range of values even if they come from different manufacturing facilities. Hydrated Portland cement has the unusual, and desirable, property that it will continue to gain strength (albeit at a decreasing rate) when in the presence of water. This complicates chemical analysis because the system is continually changing from the time of first mixing to the time of test.

The cement content analysis for Knockavrony bridge, Co. Mayo was undertaken on six samples. The samples came from deck, abutments and soffits in different levels. The mean cement content results for the six samples is 11% with a range of 5% – 15%.

#### 4.7 Half Cell and Resistivity

Corrosion of steel in concrete is one of the major problems with respect to the durability of reinforced concrete structures. Most concrete structures perform well even after a long period of use in normal environments. However, there are various reinforced concrete structures important for our infrastructure, especially bridges and buildings, which exhibit premature damage due to environmental actions (EN 206).

In contrast to mechanical actions (load, wind, etc.) the environmental actions are not reversible and accumulate hazardous components (such as chloride ions) in the concrete. A high percentage of the damage is caused by insufficient planning, wrong estimation of severity of environmental actions and by bad workmanship and thus many of these structures need to be repaired after a short service life.

Half-cell potential measurements can be performed on structures with ordinary or stainless-steel reinforcement. Corrosion of prestressing steel in concrete can be assessed in the same way. Prestressing steel in the ducts of posttensioned cables cannot be assessed.

Half-cell potential measurements are suitable mainly on reinforced concrete structures exposed to the atmosphere. The method can be applied regardless of the depth of concrete cover and the rebar size. Half-cell potential measurements will indicate corroding rebars not only in the most external layers of reinforcement facing the reference electrode but also in greater depth. The method can be used at any time during the life of a structure and in any kind of climate providing the temperature is higher than +2°C. Half-cell potential measurements should be taken only on a free concrete surface. The presence of isolating layers (asphalt, organic coatings or paints etc.) may make measurements erroneous or impossible.

In the assessment of the half-cell results, ASTM C876 uses a numeric technique to assess the half-cell potential results.

Table 1: Relationship between the potential values and corrosion probability  
(adapted from ASTM C876)

Measured Potential(mV CSE)	Probability of steelcorrosion activity
>-200	Less than 10%
-200 to -350	Uncertain
<-350	More than 90%

Based on this, it sets our three phases of corrosion activity – Initial Phase, Transient Phase, and the Final Phase. For any half-cell potential results that are > -200 it is deemed to be in the initial phase where the probability of corrosion activity is less than 10%. Where the half-cell potential results that are in the range of -200 to -350 (Transient Phase), the probability of corrosion activity is uncertain. Where the half-cell potential results that are <-350 (Final Phase), the probability of corrosion activity is more than 90%. The overall mean from all half-cell testing was -144.3.

### Half Cell Potential Results

<b>Location</b>	<b>Mean (mV)</b>	<b>Lowest (mV)</b>	<b>Highest (mV)</b>	<b>Standard Deviation (mV)</b>
Deck Area 1	-99.9	-107	-90	5.9
Soffit Area 5	-174.4	-211	-165	13.2
Soffit Area 4	-158.7	-160	-156	1.3

# Appendix A



## COMPRESSIVE STRENGTH OF A CONCRETE CORE TEST REPORT



BHP/MTIField/F058 V1 29/05/24

<b>Client:</b>	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	<b>BHP Ref. No.:</b>	24/07/055-1
		<b>Order No:</b>	Not Supplied
		<b>Date Tested:</b>	15/07/2024
<b>FAO:</b>	Lurcan Donnellan	<b>Test Specification:</b>	Customer Spec.
		<b>Test Element:</b>	Concrete Core
<b>Project:</b>	Mayo Bridges - Knockavrony Bridge		
<b>Location Reference:</b>	Area 1 Deck - Core 1		
<b>Test Standard:</b>	EN 12504-1:2019		

### Core Details

Coring Date	05/07/2024	Age of specimen	Not Specified
End of core used as datum	Top	Reinforcement in test Specimen: Size (mm)	N/A
Drilling Direction	Vertical	Reinforcement in test Specimen: Position (mm)	N/A

### Visual Assessment

Condition of specimen when received	Good	Maximum nominal size of aggregate (mm)	25
Compaction of concrete	Good	Distribution of materials	Even
Excess Voids	0.5%	Ribbing on core surface	None
Honeycombing	None	Flatness	Pass
Presence of cracks	None	Perpendicularity	Pass
Type of aggregate	Crushed Rock	Straightness	Pass

### Test Information

<b>Preparation</b>		Surface condition at time of test	Dry
Length after end preparation	102	Type of failure	Satisfactory
Diameter after end preparation	99	Average Diameter (mm)	99
Length / diameter ratio of specimen	1.03	Maximum length of specimen, as received	185
		Minimum length of specimen, as received	185
		Density of the specimen, as received (kg/m <sup>3</sup> )	2350
		Max Load (KN)	359.4
		Compressive Strength (N/mm <sup>2</sup> )	46.6

**REMARKS:**  
Method of determining volume used was displacement. Method of end preparation used was sawn & capped. The sample was stored in a sealed container prior to testing.

<b>Approved By:</b>	<b>Signature:</b>
Lukasz Zalewski Field Service Manager	

For and On Behalf of BHP Laboratories

Issue Date: 16/07/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

This test report shall not be duplicated in full without the permission of the test laboratory. Information identifying the 'Client', 'FAO', 'Project', 'Location Reference', 'Item', 'Test Specification' and 'Order No' has been provided by the customer. Results apply only to the sample tested and where the laboratory is not responsible for sampling, result apply to the sample as received. Sampling is outside the scope of accreditation.



# COMPRESSIVE STRENGTH OF A CONCRETE CORE TEST REPORT



BHP/MTIField/F058 V1 29/05/24

**Client:** TRIUR Construction Ltd  
13 Society Street  
Ballinasloe  
Galway  
**FAO:** Lurcan Donnellan

**BHP Ref. No.:** 24/07/055-2  
**Order No:** Not Supplied  
**Date Tested:** 15/07/2024  
**Test Specification:** Customer Spec.  
**Test Element:** Concrete Core

**Project:** Mayo Bridges - Knockavrony Bridge  
**Location Reference:** Area 1 Deck - Core 2  
**Test Standard:** EN 12504-1:2019

Core Details			
Coring Date	05/07/2024	Age of specimen	Not Specified
End of core used as datum	Top	Reinforcement in test Specimen: Size (mm)	N/A
Drilling Direction	Vertical	Reinforcement in test Specimen: Position (mm)	N/A

Visual Assessment			
Condition of specimen when received	Good	Maximum nominal size of aggregate (mm)	20
Compaction of concrete	Good	Distribution of materials	Even
Excess Voids	0.5%	Ribbing on core surface	None
Honeycombing	None	Flatness	Pass
Presence of cracks	None	Perpendicularity	Pass
Type of aggregate	Crushed Rock	Straightness	Pass

Test Information			
<b>Preparation</b>		Surface condition at time of test	Dry
Length after end preparation	101	Type of failure	Satisfactory
Diameter after end preparation	99	Average Diameter (mm)	99
Length / diameter ratio of specimen	1.02	Maximum length of specimen, as received	285
		Minimum length of specimen, as received	285
		Density of the specimen, as received (kg/m <sup>3</sup> )	2350
		Max Load (KN)	402.5
		Compressive Strength (N/mm <sup>2</sup> )	52.2

**REMARKS:**  
Method of determining volume used was displacement. Method of end preparation used was sawn & capped. The sample was stored in a sealed container prior to testing.

<b>Approved By:</b>  Lukasz Zalewski Field Service Manager	<b>Signature:</b>  
---	---------------------------

For and On Behalf of BHP Laboratories

Issue Date: 16/07/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

This test report shall not be duplicated in full without the permission of the test laboratory. Information identifying the 'Client', 'FAO', 'Project', 'Location Reference', 'Item', 'Test Specification' and 'Order No' has been provided by the customer. Results apply only to the sample tested and where the laboratory is not responsible for sampling, result apply to the sample as received. Sampling is outside the scope of accreditation.



## COMPRESSIVE STRENGTH OF A CONCRETE CORE TEST REPORT



BHP/MTIField/F058 V1 29/05/24

<b>Client:</b>	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	<b>BHP Ref. No.:</b>	24/07/055-3
		<b>Order No:</b>	Not Supplied
		<b>Date Tested:</b>	15/07/2024
<b>FAO:</b>	Lurcan Donnellan	<b>Test Specification:</b>	Customer Spec.
		<b>Test Element:</b>	Concrete Core
<b>Project:</b>	Mayo Bridges - Knockavrony Bridge		
<b>Location Reference:</b>	Area 2 Soffit - Core 3		
<b>Test Standard:</b>	EN 12504-1:2019		

### Core Details

Coring Date	05/07/2024	Age of specimen	Not Specified
End of core used as datum	Top	Reinforcement in test Specimen: Size (mm)	N/A
Drilling Direction	Vertical	Reinforcement in test Specimen: Position (mm)	N/A

### Visual Assessment

Condition of specimen when received	Good	Maximum nominal size of aggregate (mm)	20
Compaction of concrete	Good	Distribution of materials	Even
Excess Voids	0.5%	Ribbing on core surface	None
Honeycombing	None	Flatness	Pass
Presence of cracks	None	Perpendicularity	Pass
Type of aggregate	Crushed Rock	Straightness	Pass

### Test Information

<b>Preparation</b>		Surface condition at time of test	Dry
Length after end preparation	101	Type of failure	Satisfactory
Diameter after end preparation	99	Average Diameter (mm)	99
Length / diameter ratio of specimen	1.02	Maximum length of specimen, as received	285
		Minimum length of specimen, as received	285
		Density of the specimen, as received (kg/m <sup>3</sup> )	2330
		Max Load (KN)	414.5
		Compressive Strength (N/mm <sup>2</sup> )	53.7

**REMARKS:**  
Method of determining volume used was displacement. Method of end preparation used was sawn & capped. The sample was stored in a sealed container prior to testing.

<b>Approved By:</b>	<b>Signature:</b>
Lukasz Zalewski Field Service Manager	

For and On Behalf of BHP Laboratories

Issue Date: 16/07/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

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# COMPRESSIVE STRENGTH OF A CONCRETE CORE TEST REPORT



BHP/MTIField/F058 V1 29/05/24

**Client:** TRIUR Construction Ltd  
13 Society Street  
Ballinasloe  
Galway  
**FAO:** Lurcan Donnellan

**BHP Ref. No.:** 24/07/055-4  
**Order No:** Not Supplied  
**Date Tested:** 15/07/2024  
**Test Specification:** Customer Spec.  
**Test Element:** Concrete Core

**Project:** Mayo Bridges - Knockavrony Bridge  
**Location Reference:** Area 5 Soffit - Core 4  
**Test Standard:** EN 12504-1:2019

### Core Details

Coring Date	05/07/2024	Age of specimen	Not Specified
End of core used as datum	Top	Reinforcement in test Specimen: Size (mm)	N/A
Drilling Direction	Vertical	Reinforcement in test Specimen: Position (mm)	N/A

### Visual Assessment

Condition of specimen when received	Good	Maximum nominal size of aggregate (mm)	20
Compaction of concrete	Good	Distribution of materials	Even
Excess Voids	0.5%	Ribbing on core surface	None
Honeycombing	None	Flatness	Pass
Presence of cracks	None	Perpendicularity	Pass
Type of aggregate	Crushed Rock	Straightness	Pass

### Test Information

<b>Preparation</b>		Surface condition at time of test	Dry
Length after end preparation	102	Type of failure	Satisfactory
Diameter after end preparation	99	Average Diameter (mm)	99
Length / diameter ratio of specimen	1.03	Maximum length of specimen, as received	120
		Minimum length of specimen, as received	120
		Density of the specimen, as received (kg/m <sup>3</sup> )	2290
		Max Load (KN)	377.4
		Compressive Strength (N/mm <sup>2</sup> )	49.0

**REMARKS:**  
Method of determining volume used was displacement. Method of end preparation used was sawn & capped. The sample was stored in a sealed container prior to testing.

<b>Approved By:</b>  Lukasz Zalewski Field Service Manager	<b>Signature:</b>  
---	---------------------------

For and On Behalf of BHP Laboratories

Issue Date: 16/07/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

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# Appendix B

## BOND STRENGTH BY PULL OFF TEST REPORT



BHP/MTIField/F045 V1 15/04/24

<b>Client:</b>	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	<b>BHP Ref. No.:</b>	24/07/055
		<b>Order No:</b>	Not Supplied
		<b>Date Tested:</b>	05/07/2024
<b>FAO:</b>	Lurcan Donnellan	<b>Test Specification:</b>	Customer Spec.
		<b>Test Element:</b>	Concrete Core
<b>Project:</b>	Mayo Bridges - Knockavrony Bridge		
<b>Location Reference:</b>	Area 1 Deck - Core 1		
<b>Test Standard:</b>	BS EN 1542		

Surface Condition	Wet
Deck Surface Condition	As Supplied
Test Direction	Vertical

Test Reference	Max Applied Load (MPa)	Depth of Failure (mm)	Failure Occurred In
Area 1 top deck	1.2	3.0	Below adhesive on top of substrate
Area 1 top deck	1.1	2.0	Below adhesive on top of substrate
Area 1 top deck	0.9	1.0	Below adhesive on top of substrate
Area 1 top deck	0.8	0.0	Below adhesive on top of substrate
Area 1 top deck	1.4	2.0	Below adhesive on top of substrate
<b>Mean</b>	<b>1.08</b>		

**REMARKS:**  
Elcometer 506 Pull - Off Adhesion Tester

<b>Approved By:</b>	<b>Signature:</b>
Lukasz Zalewski <i>Field Service Manager</i>	

For and On Behalf of BHP Laboratories Issue Date: 12/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

This test report shall not be duplicated in full without the permission of the test laboratory. Information identifying the 'Client', 'FAO', 'Project', 'Location Reference', 'Item', 'Test Specification' and 'Order No' has been provided by the customer. Results apply only to the sample tested and where the laboratory is not responsible for sampling, result apply to the sample as received. Sampling is outside the scope of accreditation.

# Appendix C

## CARBONATION DEPTH OF CONCRETE TEST REPORT



BHP/MTIField/F053 V1 15/05/24

**Client:** TRIUR Construction Ltd  
13 Society Street  
Ballinasloe  
Galway

**FAO:** Lurcan Donnellan

**Project:** Mayo Bridges - Knockavrony Bridge  
**Location Reference:** See below  
**Test Standard:** BS EN 14630

**BHP Ref. No.:** 24/07/055  
**Order No.:** Not Supplied  
**Date Tested:** 15/07/2024  
**Test Specification:** Customer Spec.  
**Test Element:** Concrete Core

Location Reference	Carbonation (mm)	Notes
Area 1 Deck - 24/07/055-1	<1.0	N/A
Area 1 Deck - 24/07/055-2	<1.0	N/A
Area 5 Soffit - 24/07/055-4	10	N/A
Area 2 - 24/07/055-5	<1.0	N/A
Area 3 West Abutment - 24/07/055-6	<1.0	N/A
Area 4 Soffit - 24/07/055-7	<1.0	N/A
Area 5 - 24/07/055-8	17	N/A
Area 6 East Abutment - 24/07/055-9	24	N/A

### REMARKS:

Nil

### Approved By:

Lukasz Zalewski  
Field Service Manager

### Signature:

For and On Behalf of BHP Laboratories

Issue Date: 16/07/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

This test report shall not be duplicated in full without the permission of the test laboratory. Information identifying the 'Client', 'FAO', 'Project', 'Location Reference', 'Item', 'Test Specification' and 'Order No' has been provided by the customer. Results apply only to the sample tested and where the laboratory is not responsible for sampling, result apply to the sample as received. Sampling is outside the scope of accreditation.

# Appendix D

# TEST REPORT

Analysing  
Testing  
Consulting  
Calibrating



New Road  
Thomondgate  
Limerick  
Ireland  
Tel +353 61 455399  
Fax + 353 61 455447  
E Mail: [jamespurcell@bhp.ie](mailto:jamespurcell@bhp.ie)

**Account:** Triur Construction Ltd,  
13 Society Street,  
Ballinasloe,  
Galway

**BHP Ref No.:** 24/07/055  
**Order No.:** Not Supplied  
**Date Received:** Not Applicable  
**Date Tested:** 05/07/2024  
**Specification:** Client Specification

**Customer:** Mr. Lurcan Donnellan.

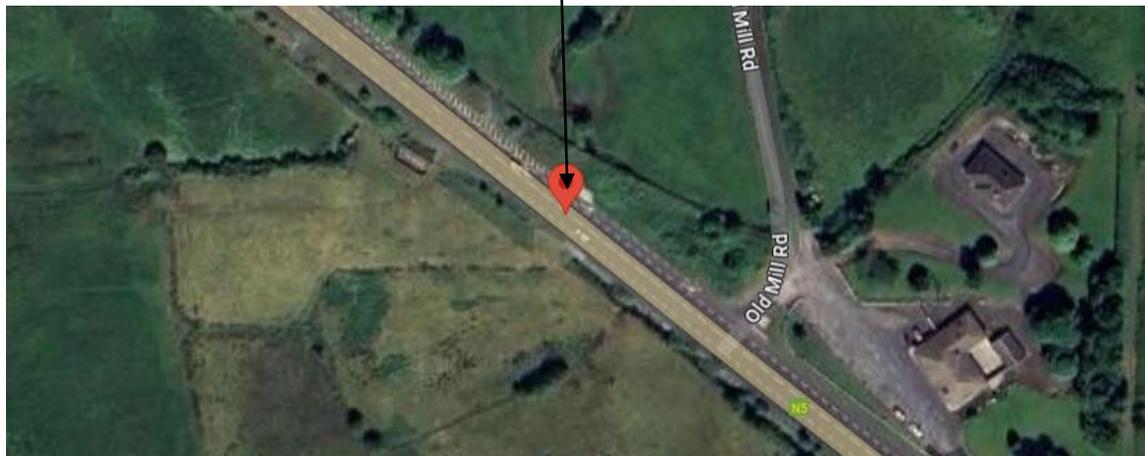
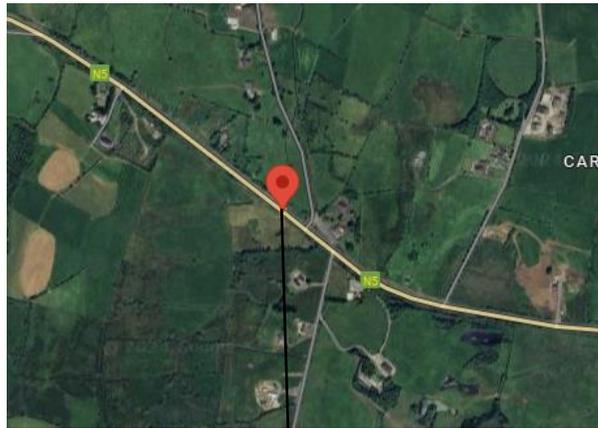
**Customer Reference:** Reinforcement Scanning at Knockavrony Bridge, Co. Mayo

## Steel Reinforcement Survey

On Friday 5th July 2024, BHP Laboratories visited Knockavrony bridge, Co. Mayo. The purpose of these specific works was to conduct a series of reinforcement scans to determine the concrete cover and reinforcement layout in concrete bridge deck and parapet.

BHP conducted this reinforcement scanning using the latest technology from Proceq – Ground Penetrating Radar & Proceq Profometer 650 AI.

### Site Location

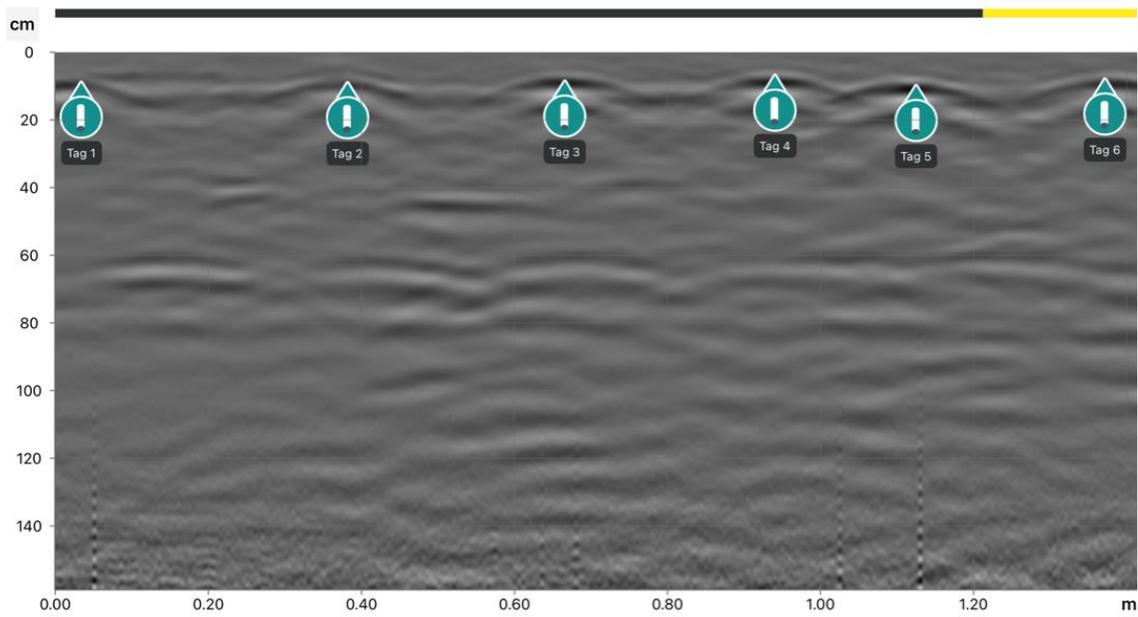


The scanning of the RC bridge deck has found the following information / key points:

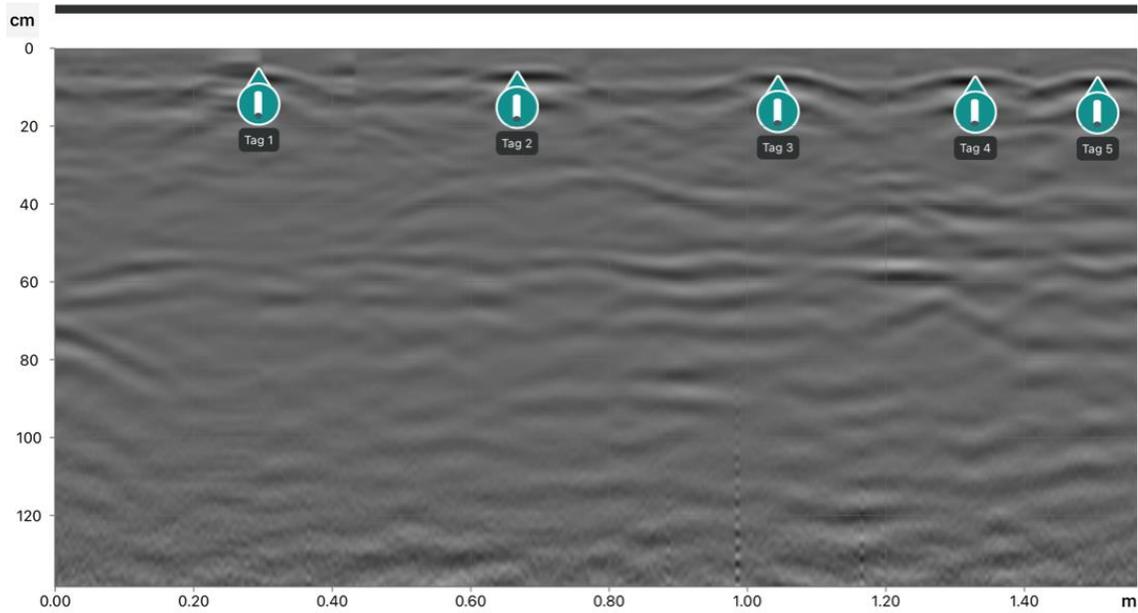
Location	Mean Cover	Mean Spacing
Area 5 Soffit transverse scan	80	266
Area 5 Soffit transverse scan	63	303
Area 5 Soffit longitudinal scan	37	277
	269	234
Area 5 Soffit longitudinal scan	61	310
Area 4 Soffit transverse scan	65	290
Area 4 Soffit transverse scan	65	290
Area 4 Soffit longitudinal scan	52	273
	347	202
Area 4 Soffit longitudinal scan	55	256
	333	220
East abutment vertical scan	0	0
East abutment vertical scan	131	250
East abutment horizontal scan	0	0
East abutment horizontal scan	201	0
West abutment horizontal scan	0	0
West abutment vertical scan	282	0
West abutment vertical scan	197	170
Deck transverse scan	94	365
West abutment horizontal scan	0	0
Deck transverse scan	96	90
Deck longitudinal scan	50	250
Deck longitudinal scan	60	237

Note: Deck soffit reinforcement spacings taken square to abutments not in direction of reinforcement. No transverse reinforcement present in the bottom of the slab, only longitudinal reinforcement present. Both transverse and longitudinal reinforcement present in top of the slab

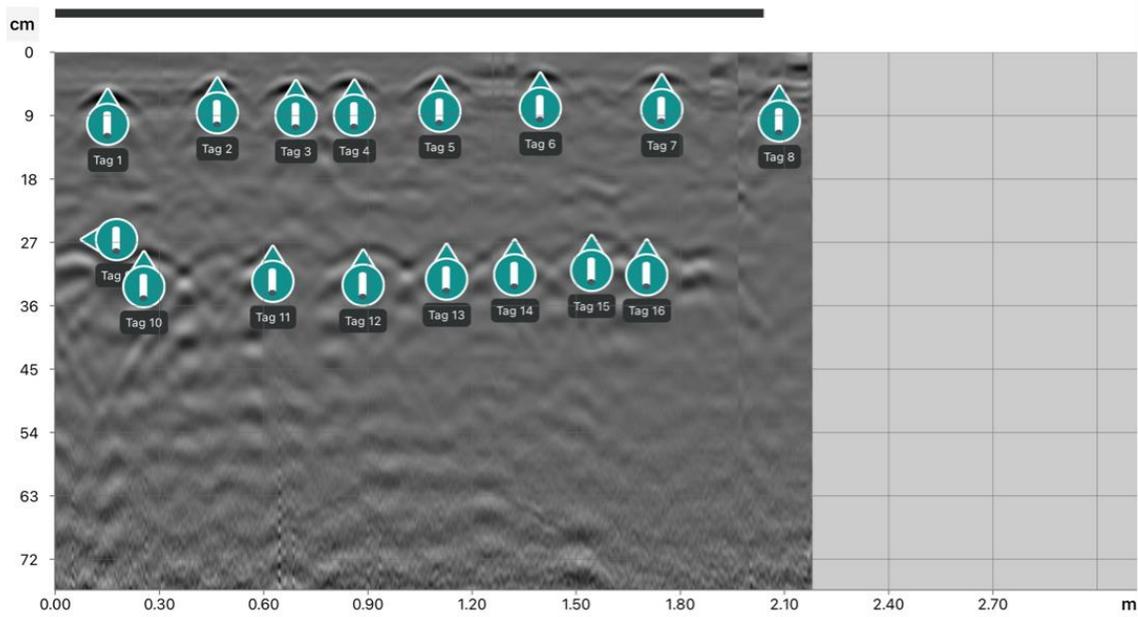
Reinforcement found by completing a breakout	Actual cover (mm)	Diameter (mm)
Longitudinal bars	40, 45	22
Area 5 soffit 2	50, 45	22



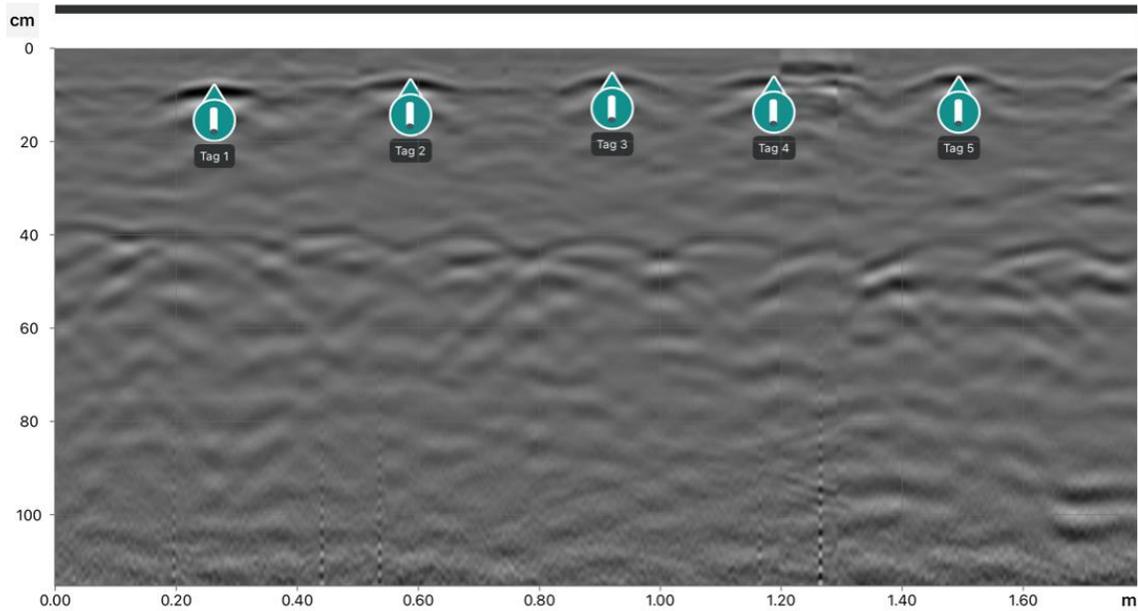
Location	Mean Cover	Mean Spacing
Area 5 Soffit transverse scan	80	266



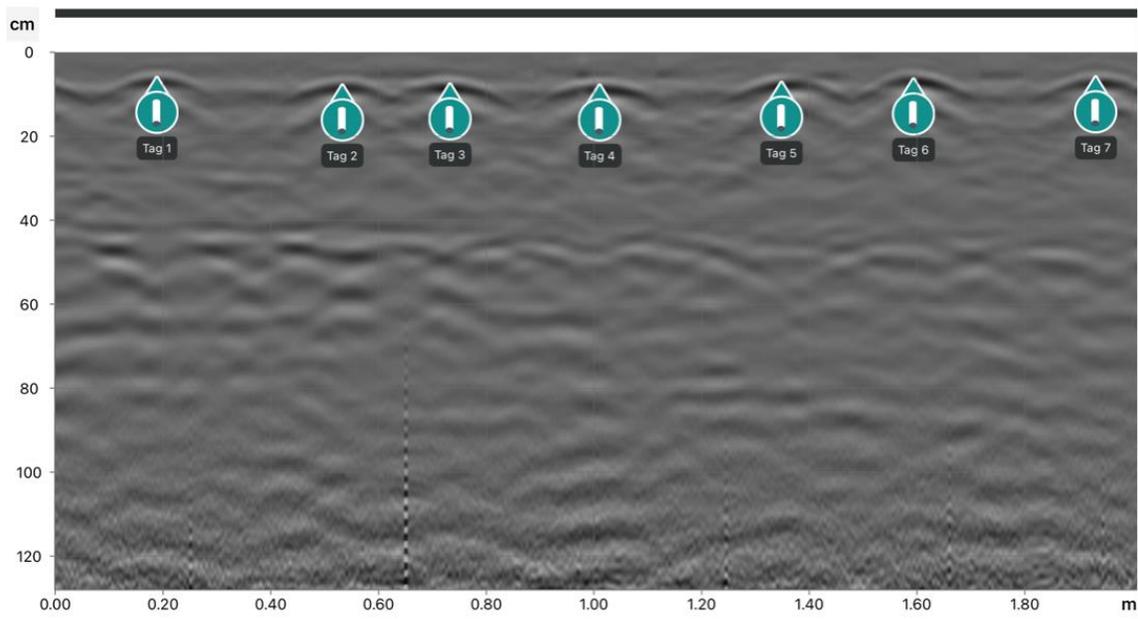
Location	Mean Cover	Mean Spacing
Area 5 Soffit transverse scan	63	303



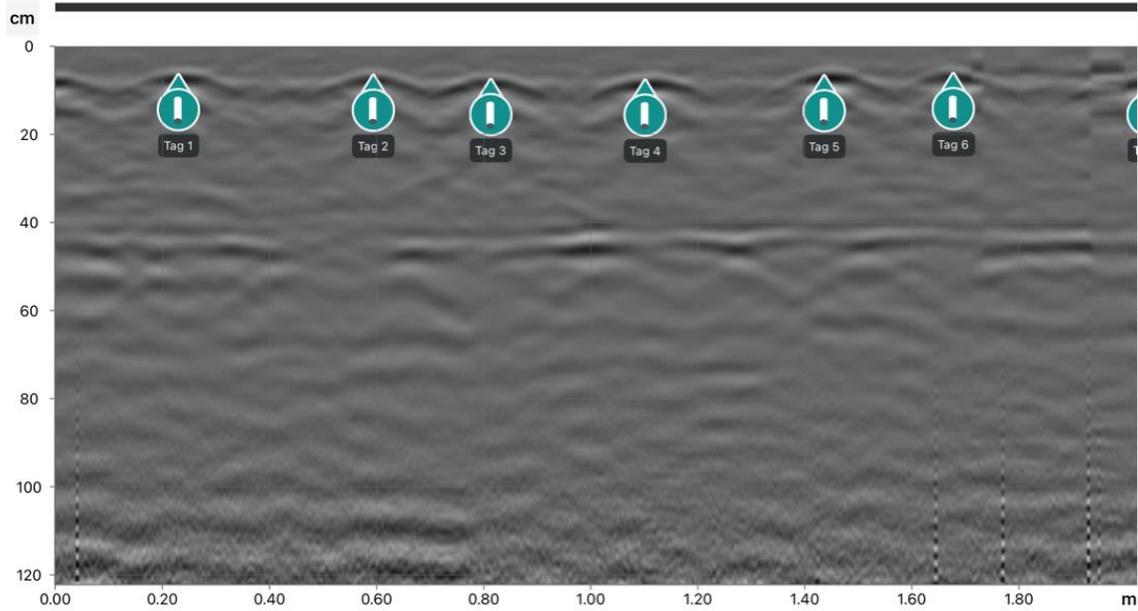
Location	Mean Cover	Mean Spacing
Area 5 Soffit longitudinal scan	37	277
	269	234



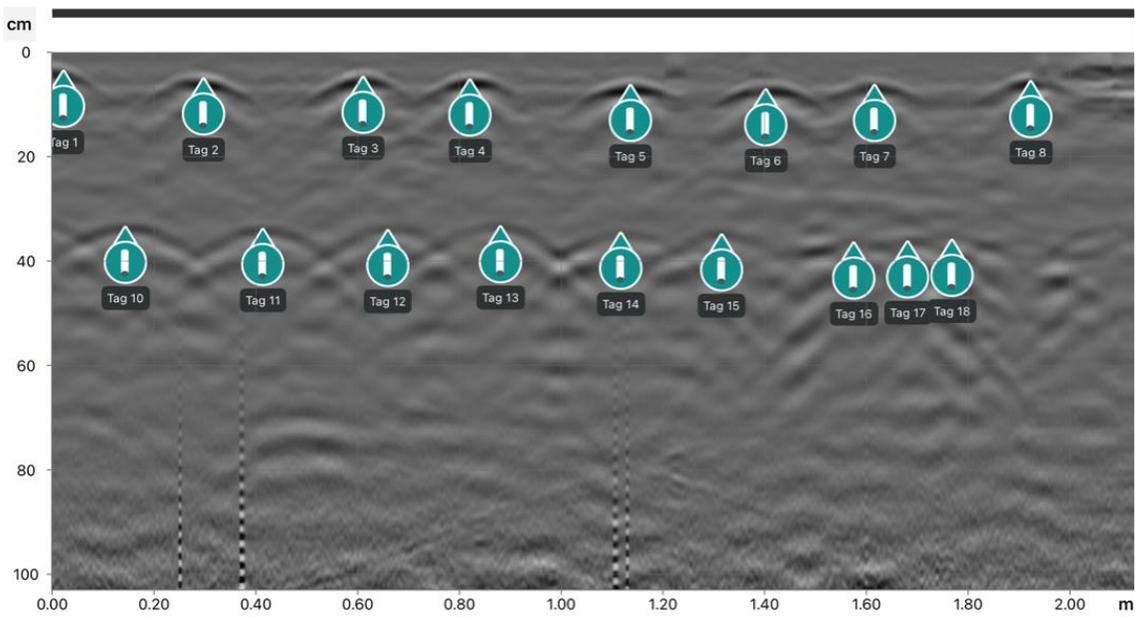
Location	Mean Cover	Mean Spacing
Area 5 Soffit longitudinal scan	61	310



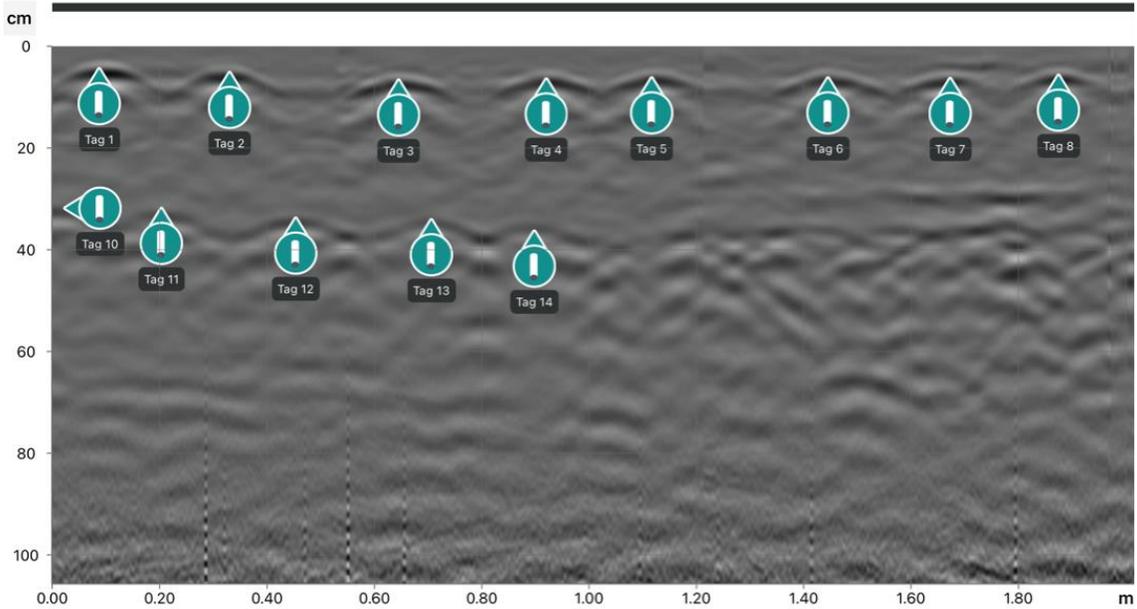
Location	Mean Cover	Mean Spacing
Area 4 Soffit transverse scan	65	290



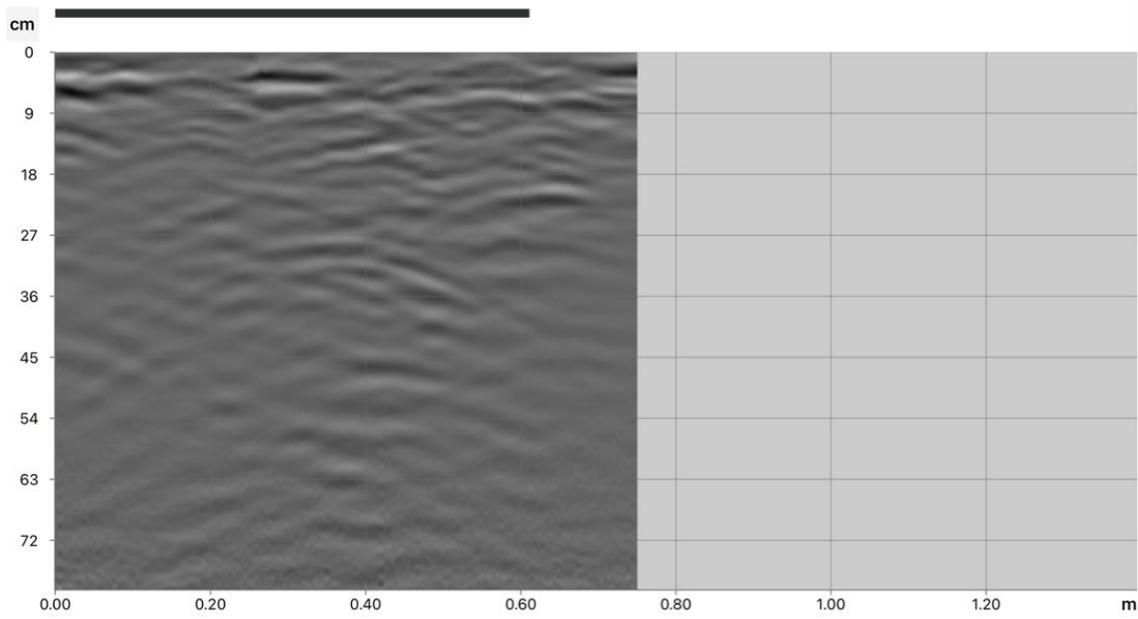
Location	Mean Cover	Mean Spacing
Area 4 Soffit transverse scan	65	290



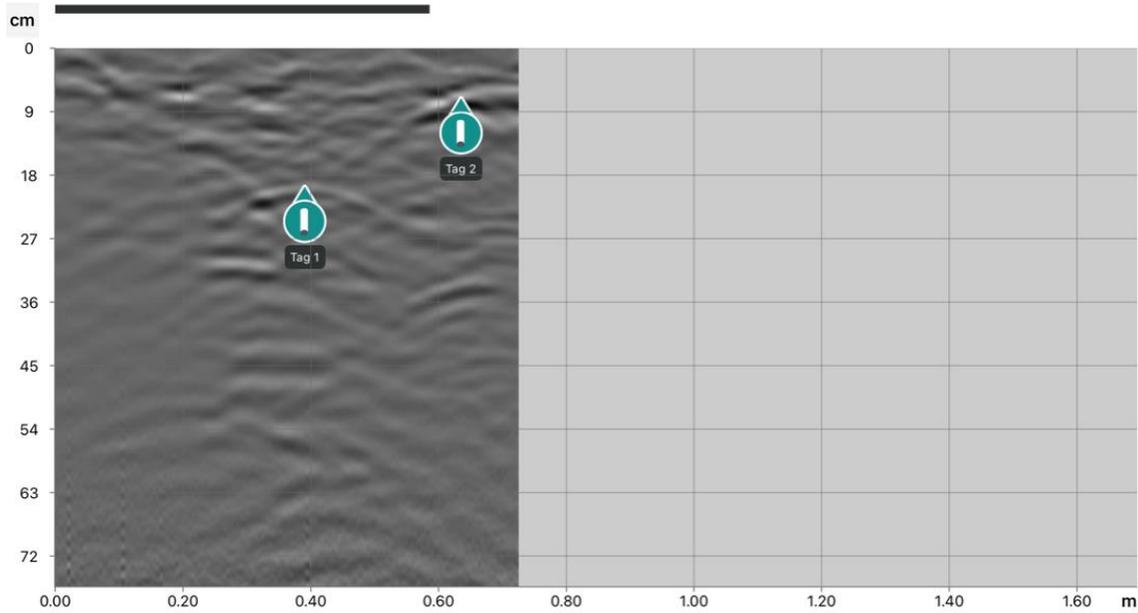
Location	Mean Cover	Mean Spacing
Area 4 Soffit longitudinal scan	52	273
	347	202



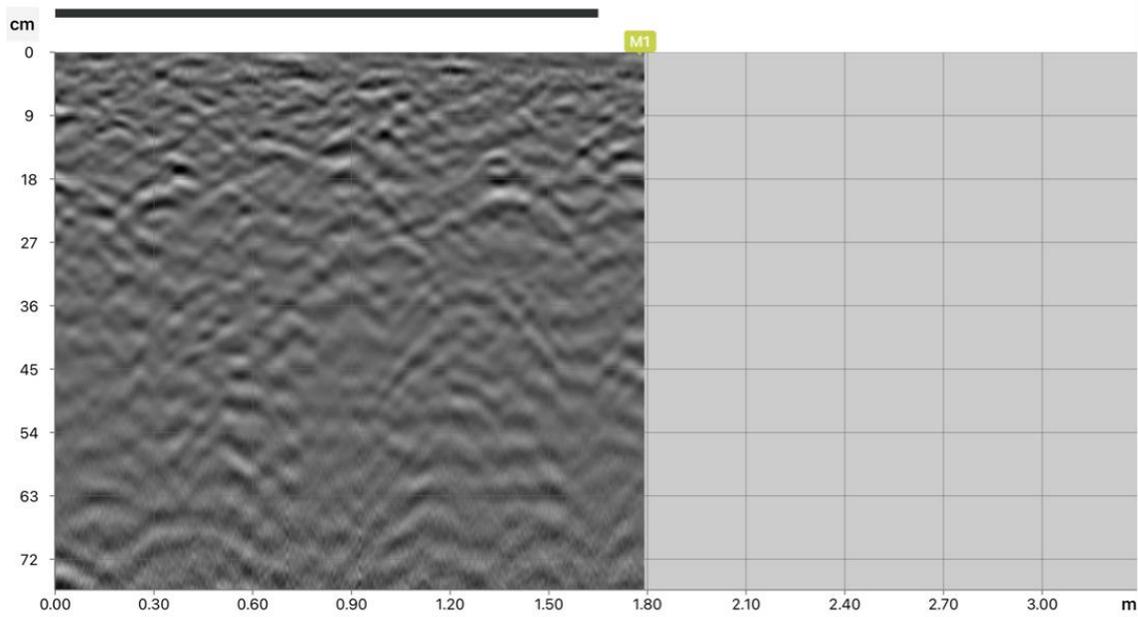
Location	Mean Cover	Mean Spacing
Area 4 Soffit longitudinal scan	55	256
	333	220



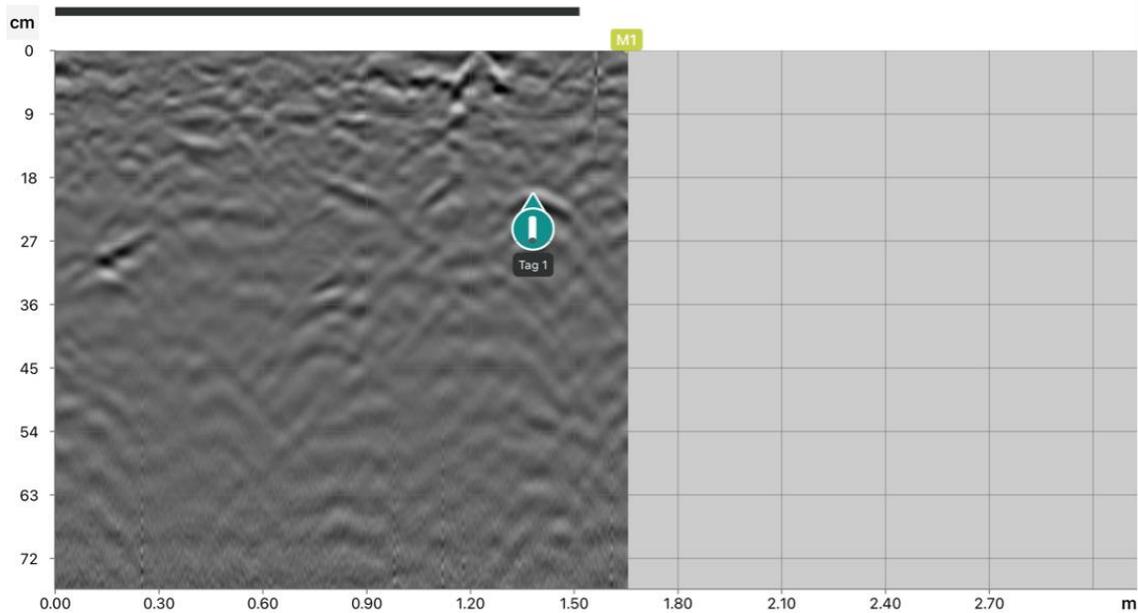
Location	Mean Cover	Mean Spacing
East abutment vertical scan	0	0



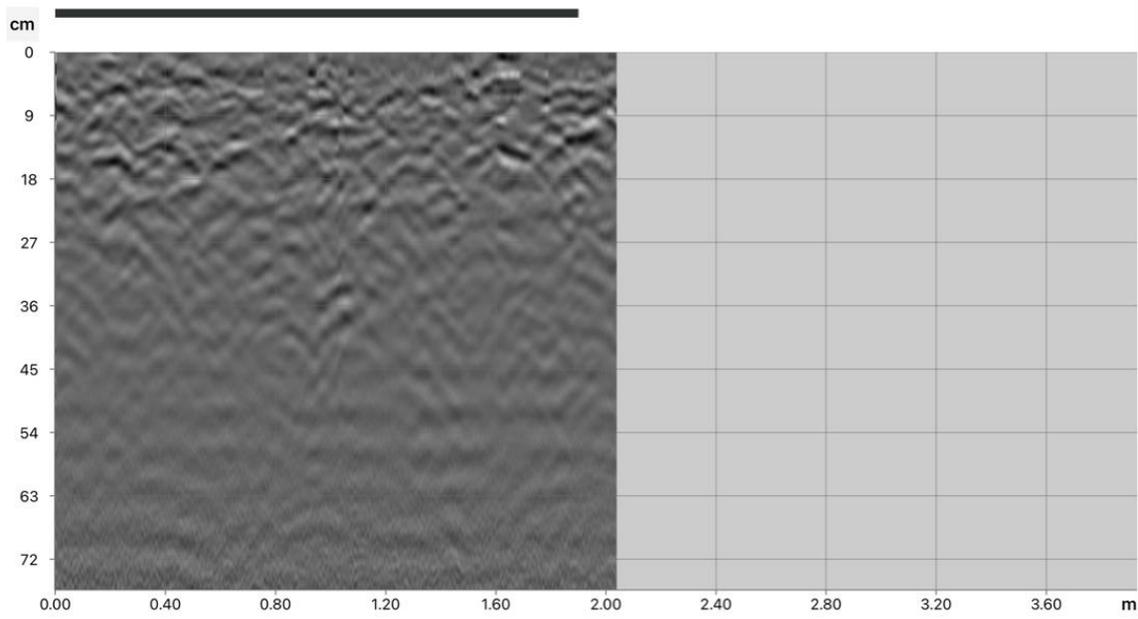
Location	Mean Cover	Mean Spacing
East abutment vertical scan	131	250



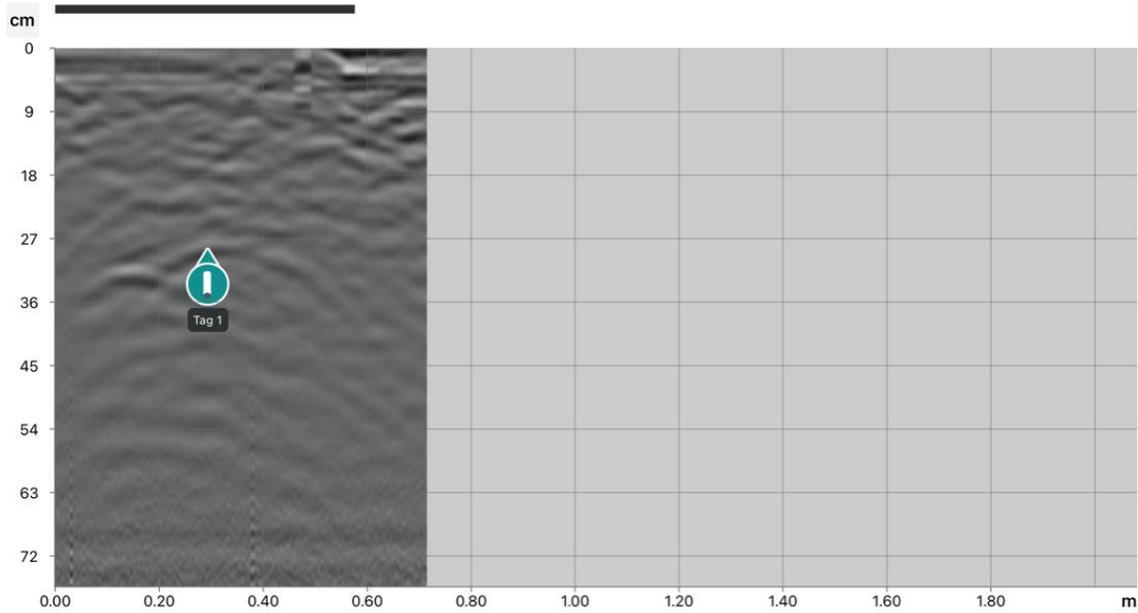
Location	Mean Cover	Mean Spacing
East abutment horizontal scan	0	0



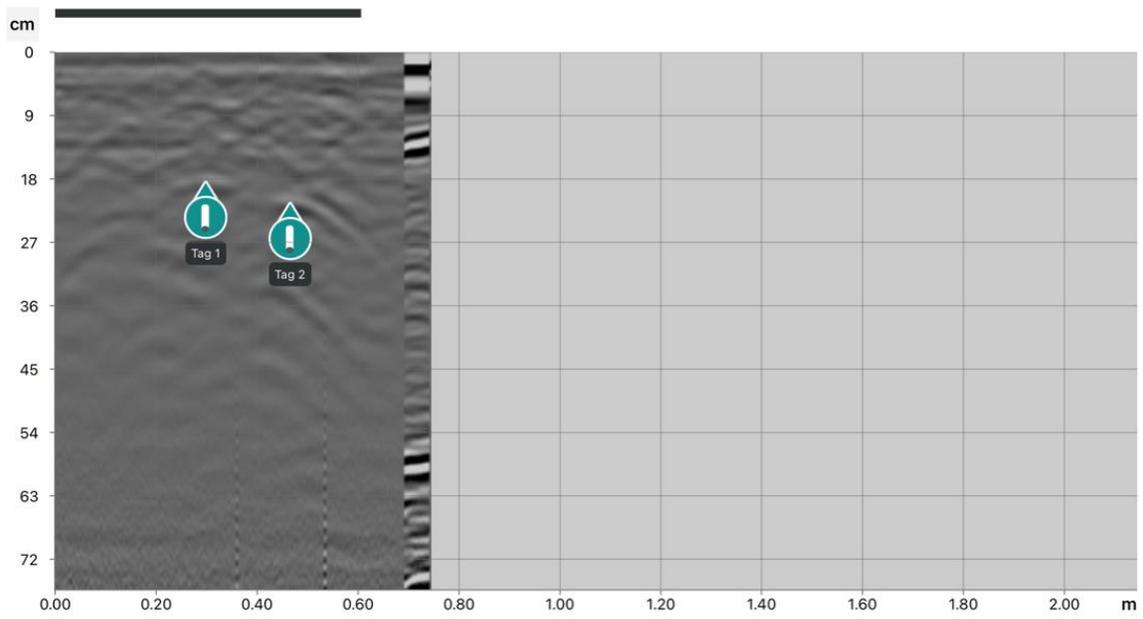
Location	Mean Cover	Mean Spacing
East abutment horizontal scan	201	0



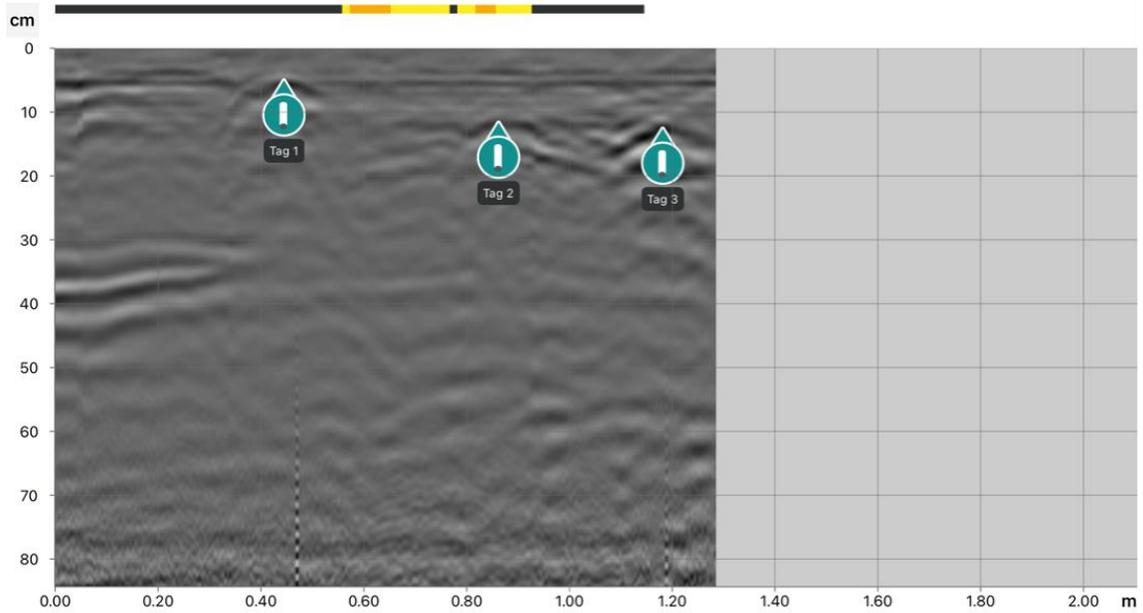
Location	Mean Cover	Mean Spacing
West abutment horizontal scan	0	0



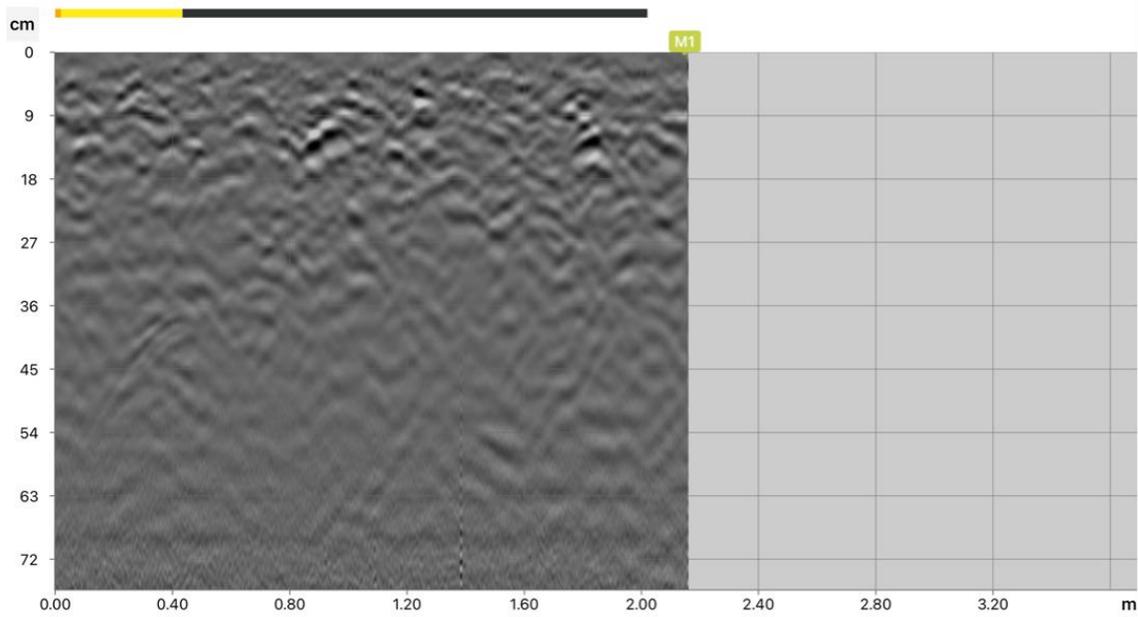
Location	Mean Cover	Mean Spacing
West abutment vertical scan	282	0



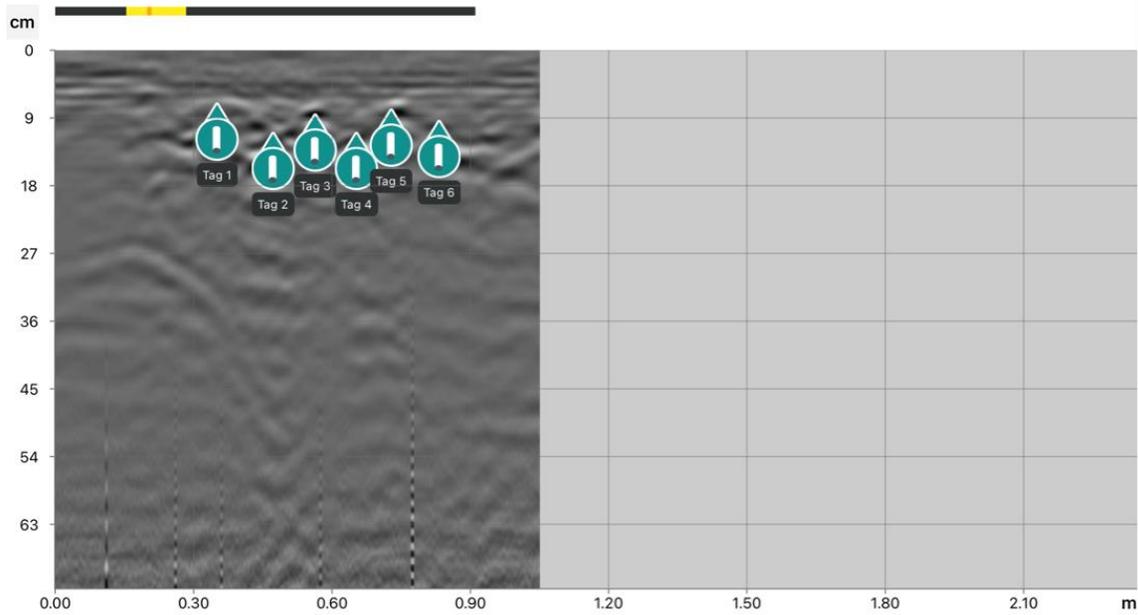
Location	Mean Cover	Mean Spacing
West abutment vertical scan	197	170



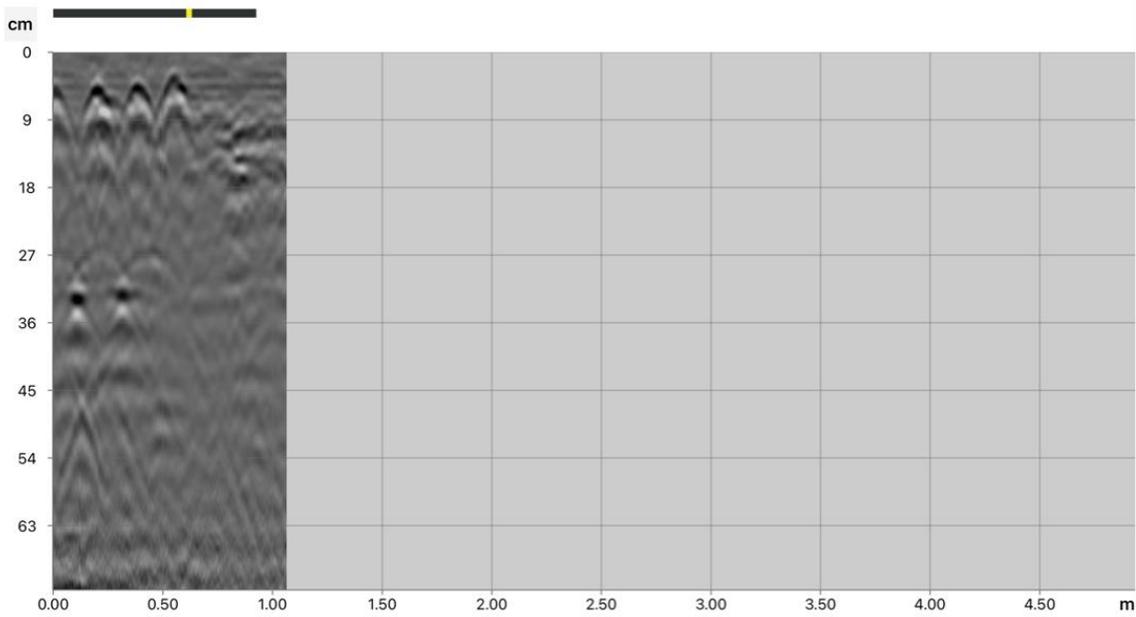
Location	Mean Cover	Mean Spacing
Deck transverse scan	94	365



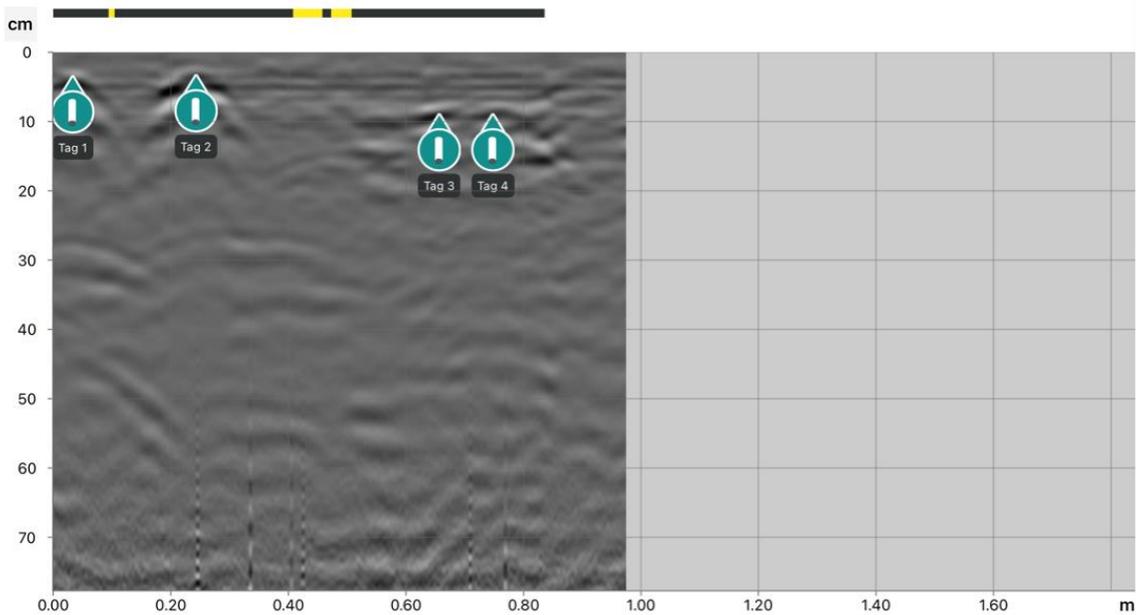
Location	Mean Cover	Mean Spacing
West abutment horizontal scan	0	0



Location	Mean Cover	Mean Spacing
Deck transverse scan	96	90



Location	Mean Cover	Mean Spacing
Deck longitudinal scan	50	250



Location	Mean Cover	Mean Spacing
Deck longitudinal scan	60	237

Photographs of breakouts

Unable to locate the transverse bars



40mm cover long bars



45mm cover longitudinal bar

20mm diameter longitudinal bar



Area 5 soffit 2 breakout



Area 5 soffit 2 - 45mm cover

Area 5 soffit 2 - 50mm cover



Area 5 soffit 2 - 20mm diameter bar



East abutment area 6 no reinforcement found



Area 3 no reinforcement found



Authorised by:

James Purcell  
Structural Testing Manager  
For and on behalf of BHP Laboratories Ltd.

Date Issued: 10<sup>th</sup> August 2024

Test results relate only to this item. This test report shall not be duplicated except in full and with the permission of the test laboratory

# Appendix E

**CHLORIDE CONTENT OF CONCRETE  
TEST REPORT**



BHP/MT/Field/F063 V1 08/07/24

**Client:** TRIUR Construction Ltd  
13 Society Street  
Ballinasloe  
Galway  
**FAO:** Lurcan Donnellan

**BHP Ref. No.:** 24/07/055-1-3  
**Order No:** Not Supplied  
**Date Tested:** 08/08/2024  
**Test Specification:** Customer Spec.  
**Test Element:** Concrete Dust

**Project:** Mayo Bridges - Knockavrony Bridge  
**Location Reference:** Knockavrony bridge  
**Test Standard:** BS 1881 Part 124

Location Reference	Sample Reference	Depth (mm)	Chloride Content % by mass of	
			Sample	Cement
Area 1 - Deck	24/07/055-1	5-30	0.02	12.50
		30-55	0.01	7.14
		55-80	0.01	8.33
		80-105	0.02	14.29
Area 2 - Face Deck	24/07/055-2	5-30	0.03	5.77
		30-55	0.05	5.68
		55-80	0.04	5.56
		80-105	0.04	6.25
Area 3 - West abutment	24/07/055-3	5-30	0.01	16.67
		30-55	0.03	15.00
		55-80	0.02	12.50
		80-105	0.02	16.67

**REMARKS:**  
The Chloride Content is a Acid Soluble Chloride value.  
The Chloride Content as a % by mass of cements as stated in EN 206 is a maxium allowable of 0.4% (containing embedded steel).

<b>Approved By:</b>	<b>Signature:</b>
Lukasz Zalewski Field Service Manager	

For and On Behalf of BHP Laboratories Issue Date: 12/08/2024  
Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie  
This test report shall not be duplicated in full without the permission of the test laboratory. Information identifying the 'Client', 'FAO', 'Project', 'Location Reference', 'Item', 'Test Specification' and 'Order No' has been provided by the customer. Results apply only to the sample tested and where the laboratory is not responsible for sampling, result apply to the sample as received. Sampling is outside the scope of accreditation.

**CHLORIDE CONTENT OF CONCRETE  
TEST REPORT**



BHP/MT/Field/F063 V1 08/07/24

**Client:** TRIUR Construction Ltd  
13 Society Street  
Ballinasloe  
Galway  
**FAO:** Lurcan Donnellan

**BHP Ref. No.:** 24/07/055-4-6  
**Order No:** Not Supplied  
**Date Tested:** 08/08/2024  
**Test Specification:** Customer Spec.  
**Test Element:** Concrete Dust

**Project:** Mayo Bridges - Knockavrony Bridge  
**Location Reference:** Knockavrony bridge  
**Test Standard:** BS 1881 Part 124

Location Reference	Sample Reference	Depth (mm)	Chloride Content % by mass of	
			Sample	Cement
Area 4 - Soffit 1	24/07/055-4	5-30	0.01	16.67
		30-55	0.01	10.00
		55-80	0.01	8.33
		80-105	0.01	10.00
Area 5 - Soffit 2	24/07/055-5	5-30	0.01	10.00
		30-55	0.02	20.00
		55-80	0.01	12.50
		80-105	0.01	16.67
Area 6 - East abutment	24/07/055-6	5-30	0.01	8.33
		30-55	0.01	6.25
		55-80	0.01	10.00
		80-105	0.01	7.14

**REMARKS:**  
The Chloride Content is a Acid Soluble Chloride value.  
The Chloride Content as a % by mass of cements as stated in EN 206 is a maxium allowable of 0.4% (containing embedded steel).

<b>Approved By:</b>	<b>Signature:</b>
Lukasz Zalewski Field Service Manager	

# Appendix F

**CEMENT CONTENT OF CONCRETE  
TEST REPORT**



BHP/MTIField/F056 V1 20/05/24

<b>Client:</b>	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	<b>BHP Ref. No.:</b>	24/07/055-1
<b>FAO:</b>	Lurcan Donnellan	<b>Order No:</b>	Not Supplied
		<b>Date Tested:</b>	08/08/2024
		<b>Test Specification:</b>	Customer Spec.
		<b>Test Element:</b>	Concrete Dust
<b>Project:</b>	Mayo Bridges - Knockavrony Bridge		
<b>Location Reference:</b>	Area 1 - Deck		
<b>Test Standard:</b>	BS 1881 Part 124		

<b>Sample Weight (g)</b>	<b>6</b>
<b>Determined Values</b>	
Insoluble residue (%)	<b>7.3</b>
Soluble silica (%)	<b>2.4</b>
Calcium oxide (%)	<b>47.4</b>
<b>Calculated Values</b>	
Cement Content (%)	
ex silica	<b>11</b>
ex lime	<b>73.5</b>
preferred / mean value %	<b>11</b>
Reported to nearest whole figure (%)	<b>11</b>
<b>Aggregate Content (%)</b>	
ex silica	<b>86.4</b>
ex lime	<b>9.6</b>
preferred / mean value	<b>86.4</b>
<b>Aggregate / Cement Ratio</b>	
ex silica	<b>7.8</b>
ex lime	<b>0.1</b>
preferred / mean value	<b>7.8</b>

**REMARKS:**  
 The cement contents were determined in accordance with B.S. 1881:Part 124:2015+A1:2021. The silica content was determined using inductively coupled plasma optical emission spectroscopy.  
 Assumptions used for the cement and aggregate content calculations:  
 Silica content of cement (CEM I)            20.2%  
 Soluble silica content of aggregate        0.5%  
 Calcium oxide content of cement (CEM I)   64.5%

<b>Approved By:</b>	<b>Signature:</b>
Lukasz Zalewski Field Service Manager	

For and On Behalf of BHP Laboratories Issue Date: 12/08/2024  
 Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie  
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**CEMENT CONTENT OF CONCRETE  
TEST REPORT**



BHP/MTIField/F056 V1 20/05/24

<b>Client:</b>	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	<b>BHP Ref. No.:</b>	24/07/055-2
<b>FAO:</b>	Lurcan Donnellan	<b>Order No:</b>	Not Supplied
		<b>Date Tested:</b>	08/08/2024
		<b>Test Specification:</b>	Customer Spec.
		<b>Test Element:</b>	Concrete Dust
<b>Project:</b>	Mayo Bridges - Knockavrony Bridge		
<b>Location Reference:</b>	Area 2 - Face deck		
<b>Test Standard:</b>	BS 1881 Part 124		

<b>Sample Weight (g)</b>	6
<b>Determined Values</b>	
Insoluble residue (%)	5.3
Soluble silica (%)	1.3
Calcium oxide (%)	48.9
<b>Calculated Values</b>	
Cement Content (%)	
ex silica	5.5
ex lime	75.9
preferred / mean value %	5.5
Reported to nearest whole figure (%)	5
<b>Aggregate Content (%)</b>	
ex silica	93.3
ex lime	6.7
preferred / mean value	93.3
<b>Aggregate / Cement Ratio</b>	
ex silica	17.1
ex lime	0.1
preferred / mean value	17.1

**REMARKS:**  
 The cement contents were determined in accordance with B.S. 1881:Part 124:2015+A1:2021. The silica content was determined using inductively coupled plasma optical emission spectroscopy.  
 Assumptions used for the cement and aggregate content calculations:  
 Silica content of cement (CEM I) 20.2%  
 Soluble silica content of aggregate 0.5%  
 Calcium oxide content of cement (CEM I) 64.5%

<b>Approved By:</b>	<b>Signature:</b>
Lukasz Zalewski Field Service Manager	

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**CEMENT CONTENT OF CONCRETE  
TEST REPORT**



BHP/MTIField/F056 V1 20/05/24

<b>Client:</b>	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	<b>BHP Ref. No.:</b>	24/07/055-3
<b>FAO:</b>	Lurcan Donnellan	<b>Order No:</b>	Not Supplied
		<b>Date Tested:</b>	08/08/2024
		<b>Test Specification:</b>	Customer Spec.
		<b>Test Element:</b>	Concrete Dust
<b>Project:</b>	Mayo Bridges - Knockavrony Bridge		
<b>Location Reference:</b>	Area 3 - West abutment		
<b>Test Standard:</b>	BS 1881 Part 124		

<b>Sample Weight (g)</b>	<b>6</b>
<b>Determined Values</b>	
Insoluble residue (%)	<b>14.2</b>
Soluble silica (%)	<b>3.2</b>
Calcium oxide (%)	<b>43.9</b>
<b>Calculated Values</b>	
Cement Content (%)	
ex silica	<b>15</b>
ex lime	<b>68</b>
preferred / mean value %	<b>15</b>
Reported to nearest whole figure (%)	<b>15</b>
<b>Aggregate Content (%)</b>	
ex silica	<b>81.6</b>
ex lime	<b>16.3</b>
preferred / mean value	<b>81.6</b>
<b>Aggregate / Cement Ratio</b>	
ex silica	<b>5.4</b>
ex lime	<b>0.2</b>
preferred / mean value	<b>5.4</b>

**REMARKS:**  
 The cement contents were determined in accordance with B.S. 1881:Part 124:2015+A1:2021. The silica content was determined using inductively coupled plasma optical emission spectroscopy.  
 Assumptions used for the cement and aggregate content calculations:  
 Silica content of cement (CEM I)           20.2%  
 Soluble silica content of aggregate        0.5%  
 Calcium oxide content of cement (CEM I)   64.5%

<b>Approved By:</b>	<b>Signature:</b>
Lukasz Zalewski Field Service Manager	

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**CEMENT CONTENT OF CONCRETE  
TEST REPORT**



BHP/MTIField/F056 V1 20/05/24

<b>Client:</b>	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	<b>BHP Ref. No.:</b>	24/07/055-4
<b>FAO:</b>	Lurcan Donnellan	<b>Order No:</b>	Not Supplied
		<b>Date Tested:</b>	08/08/2024
		<b>Test Specification:</b>	Customer Spec.
		<b>Test Element:</b>	Concrete Dust
<b>Project:</b>	Mayo Bridges - Knockavrony Bridge		
<b>Location Reference:</b>	Area 4 - Soffit 1		
<b>Test Standard:</b>	BS 1881 Part 124		

<b>Sample Weight (g)</b>	7
<b>Determined Values</b>	
Insoluble residue (%)	9.7
Soluble silica (%)	2.6
Calcium oxide (%)	46.4
<b>Calculated Values</b>	
Cement Content (%)	
ex silica	11.8
ex lime	72
preferred / mean value %	11.8
Reported to nearest whole figure (%)	12
<b>Aggregate Content (%)</b>	
ex silica	85.5
ex lime	11.5
preferred / mean value	85.5
<b>Aggregate / Cement Ratio</b>	
ex silica	7.3
ex lime	0.2
preferred / mean value	7.3

**REMARKS:**  
 The cement contents were determined in accordance with B.S. 1881:Part 124:2015+A1:2021. The silica content was determined using inductively coupled plasma optical emission spectroscopy.  
 Assumptions used for the cement and aggregate content calculations:  
 Silica content of cement (CEM I) 20.2%  
 Soluble silica content of aggregate 0.5%  
 Calcium oxide content of cement (CEM I) 64.5%

<b>Approved By:</b>	<b>Signature:</b>
Lukasz Zalewski Field Service Manager	

For and On Behalf of BHP Laboratories Issue Date: 12/08/2024  
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**CEMENT CONTENT OF CONCRETE  
TEST REPORT**



BHP/MTIField/F056 V1 20/05/24

<b>Client:</b>	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	<b>BHP Ref. No.:</b>	24/07/055-5
<b>FAO:</b>	Lurcan Donnellan	<b>Order No:</b>	Not Supplied
		<b>Date Tested:</b>	08/08/2024
		<b>Test Specification:</b>	Customer Spec.
		<b>Test Element:</b>	Concrete Dust
<b>Project:</b>	Mayo Bridges - Knockavrony Bridge		
<b>Location Reference:</b>	Area 5 - Soffit 2		
<b>Test Standard:</b>	BS 1881 Part 124		

<b>Sample Weight (g)</b>	17
<b>Determined Values</b>	
Insoluble residue (%)	11.3
Soluble silica (%)	3.3
Calcium oxide (%)	45.9
<b>Calculated Values</b>	
Cement Content (%)	
ex silica	15.3
ex lime	71.2
preferred / mean value %	15.3
Reported to nearest whole figure (%)	15
<b>Aggregate Content (%)</b>	
ex silica	81.2
ex lime	12.5
preferred / mean value	81.2
<b>Aggregate / Cement Ratio</b>	
ex silica	5.3
ex lime	0.2
preferred / mean value	5.3

**REMARKS:**  
 The cement contents were determined in accordance with B.S. 1881:Part 124:2015+A1:2021. The silica content was determined using inductively coupled plasma optical emission spectroscopy.  
 Assumptions used for the cement and aggregate content calculations:  
 Silica content of cement (CEM I)      20.2%  
 Soluble silica content of aggregate      0.5%  
 Calcium oxide content of cement (CEM I)      64.5%

<b>Approved By:</b>	<b>Signature:</b>
Lukasz Zalewski Field Service Manager	

For and On Behalf of BHP Laboratories Issue Date: 12/08/2024  
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**CEMENT CONTENT OF CONCRETE  
TEST REPORT**



BHP/MTIField/F056 V1 20/05/24

<b>Client:</b>	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	<b>BHP Ref. No.:</b>	24/07/055-6
<b>FAO:</b>	Lurcan Donnellan	<b>Order No:</b>	Not Supplied
		<b>Date Tested:</b>	08/08/2024
		<b>Test Specification:</b>	Customer Spec.
		<b>Test Element:</b>	Concrete Dust
<b>Project:</b>	Mayo Bridges - Knockavrony Bridge		
<b>Location Reference:</b>	Area 6 - East abutment		
<b>Test Standard:</b>	BS 1881 Part 124		

<b>Sample Weight (g)</b>	15
<b>Determined Values</b>	
Insoluble residue (%)	14.3
Soluble silica (%)	1.5
Calcium oxide (%)	45.7
<b>Calculated Values</b>	
Cement Content (%)	
ex silica	6.4
ex lime	70.8
preferred / mean value %	6.4
Reported to nearest whole figure (%)	6
<b>Aggregate Content (%)</b>	
ex silica	92.1
ex lime	12.9
preferred / mean value	92.1
<b>Aggregate / Cement Ratio</b>	
ex silica	14.4
ex lime	0.2
preferred / mean value	14.4

**REMARKS:**  
 The cement contents were determined in accordance with B.S. 1881:Part 124:2015+A1:2021. The silica content was determined using inductively coupled plasma optical emission spectroscopy.  
 Assumptions used for the cement and aggregate content calculations:  
 Silica content of cement (CEM I)      20.2%  
 Soluble silica content of aggregate      0.5%  
 Calcium oxide content of cement (CEM I)      64.5%

<b>Approved By:</b>	<b>Signature:</b>
Lukasz Zalewski Field Service Manager	

For and On Behalf of BHP Laboratories Issue Date: 12/08/2024  
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# Appendix G

**CORROSION POTENTIAL ASSESSMENT OF STEEL  
REINFORCEMENT BY HALF CELL TESTING  
TEST REPORT**

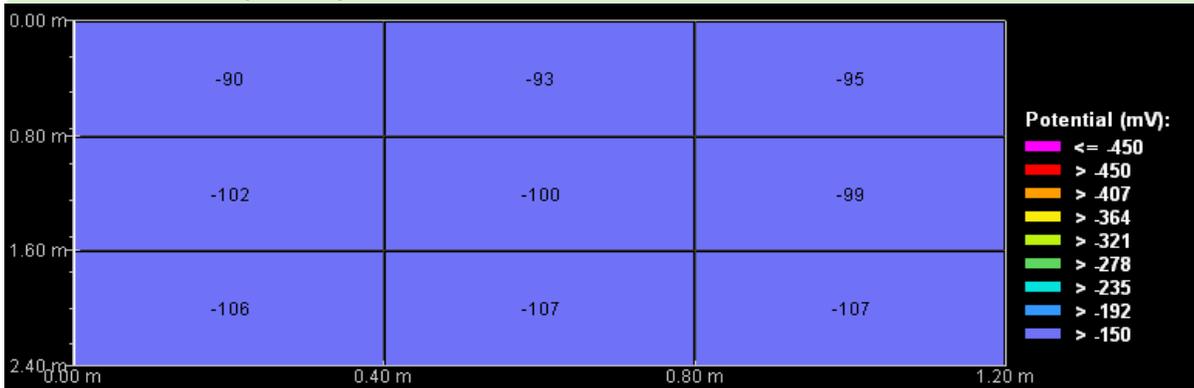


BHP/MTIField/F057 V1 21/05/24

<b>Client:</b>	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	<b>BHP Ref. No.:</b>	24/07/055-1
		<b>Order No:</b>	Not Supplied
		<b>Date Tested:</b>	05/07/2024
<b>FAO:</b>	Lurcan Donnellan	<b>Test Specification:</b>	Customer Spec.
		<b>Test Element:</b>	Concrete Deck
<b>Project:</b>	Mayo Bridges - Knockavrony Bridge		
<b>Location Reference:</b>	Deck Area 1		
<b>Test Standard:</b>	ASTM C876		

Test No.	1
No. of Readings	9
Median (mV)	-100
Mean (mV)	-99.9
Standard Deviation	5.9
Lowest (mV)	-107
Highest (mV)	-90
Reinforcement Condition	Low risk of corrosion

**Graphical Representation of Measured Potential Field of Concrete Concrete Deck**



**REMARKS:**

This test was performed using a Copper-Copper Sulphate Electrode.

<b>Approved By:</b>	<b>Signature:</b>
Lukasz Zalewski Field Service Manager	

For and On Behalf of BHP Laboratories

Issue Date:

12/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

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**CORROSION POTENTIAL ASSESSMENT OF STEEL  
REINFORCEMENT BY HALF CELL TESTING  
TEST REPORT**

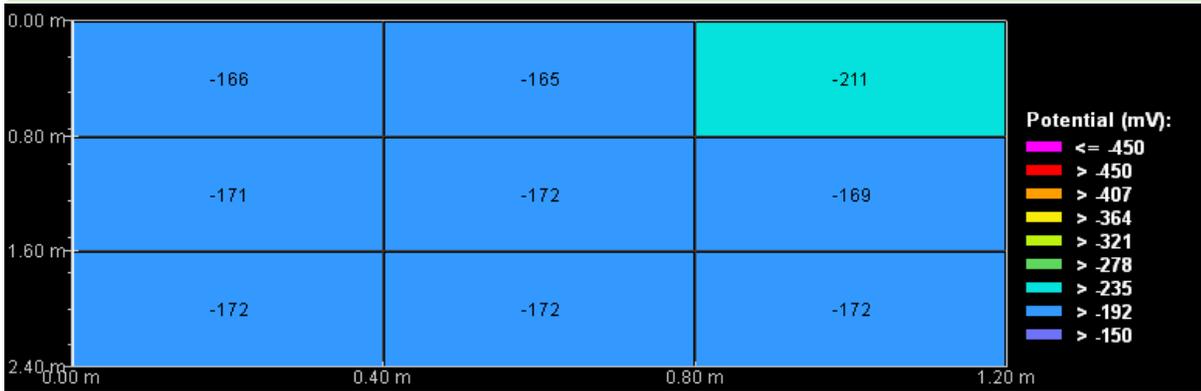


BHP/MTIField/F057 V1 21/05/24

<b>Client:</b>	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	<b>BHP Ref. No.:</b>	24/07/055-2
<b>FAO:</b>	Lurcan Donnellan	<b>Order No:</b>	Not Supplied
<b>Project:</b>	Mayo Bridges - Knockavrony Bridge	<b>Date Tested:</b>	05/07/2024
<b>Location Reference:</b>	Soffit Area 5	<b>Test Specification:</b>	Customer Spec.
<b>Test Standard:</b>	ASTM C876	<b>Test Element:</b>	Concrete Deck

Test No.	2
No. of Readings	9
Median (mV)	-172
Mean (mV)	-174.4
Standard Deviation	13.2
Lowest (mV)	-211
Highest (mV)	-165
Reinforcement Condition	Low risk of corrosion

**Graphical Representation of Measured Potential Field of Concrete Concrete Deck**



**REMARKS:**

This test was performed using a Copper-Copper Sulphate Electrode.

<b>Approved By:</b>  Lukasz Zalewski Field Service Manager	<b>Signature:</b>  
---	---------------------------

For and On Behalf of BHP Laboratories

Issue Date:

12/08/2024

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**CORROSION POTENTIAL ASSESSMENT OF STEEL  
REINFORCEMENT BY HALF CELL TESTING  
TEST REPORT**

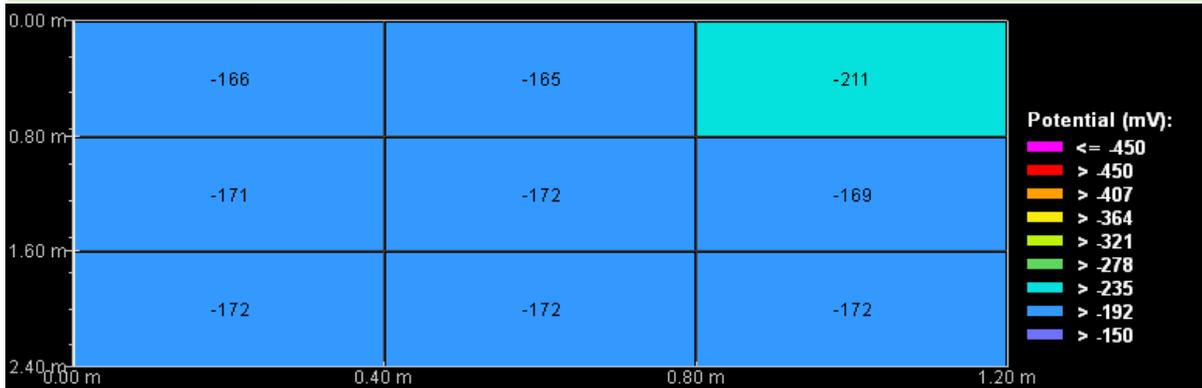


BHP/MTIField/F057 V1 21/05/24

<b>Client:</b>	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	<b>BHP Ref. No.:</b>	24/07/055-3
<b>FAO:</b>	Lurcan Donnellan	<b>Order No:</b>	Not Supplied
<b>Project:</b>	Mayo Bridges - Knockavrony Bridge	<b>Date Tested:</b>	05/07/2024
<b>Location Reference:</b>	Soffit Area 4	<b>Test Specification:</b>	Customer Spec.
<b>Test Standard:</b>	ASTM C876	<b>Test Element:</b>	Concrete Deck

Test No.	3
No. of Readings	9
Median (mV)	-159
Mean (mV)	-158.7
Standard Deviation	1.3
Lowest (mV)	-160
Highest (mV)	-156
Reinforcement Condition	Low risk of corrosion

**Graphical Representation of Measured Potential Field of Concrete Concrete Deck**



**REMARKS:**

This test was performed using a Copper-Copper Sulphate Electrode.

<b>Approved By:</b>	<b>Signature:</b>
Lukasz Zalewski Field Service Manager	

For and On Behalf of BHP Laboratories

Issue Date:

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# DETERMINATION OF RESISTIVITY OF CONCRETE



BHP/MTIField/F048 V1 30/04/24

**Client:** TRIUR Construction Ltd  
13 Society Street  
Ballinasloe  
Galway

**FAO:** Lurcan Donnellan

**BHP Ref. No.:** 24/07/055-1  
**Order No:** Not Supplied  
**Date Tested:** 05/07/2024  
**Test Specification:** Client Spec.  
**Material** Concrete Element

**Project:** Mayo Bridges - Knockavrony Bridge  
**Location Reference:** Area 1  
**Test Standard:** EN 12390-19 2021

RESULTS				
Structural Element	Deck			
Measurement Mode	Surface			
Contact Spacing	50mm			
Specimen Shape	Flat			
Dimensions of Test Area (mm)	400x400			
Minimum Measurement (kΩcm)	188			
Maximum Measurement (kΩcm)	198			
Mean Value (kΩcm)	194			
Interpretation of Result	Negligible risk of corrosion			
Resistivity Measurements (kΩcm)				
<b>195</b>	<b>198</b>	<b>194</b>	<b>193</b>	<b>188</b>
<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>

**REMARKS:**

Resistivity measurements can be used to estimate the likelihood of corrosion. When the electrical resistivity of the concrete is low, the likelihood of corrosion increases. When the electrical resistivity is high, the likelihood of corrosion decreases.

A guide to interpretation of resistivity results is:

- When ≥ 100 kΩcm                      Negligible risk of corrosion
- When 50 to 100 kΩcm                Low risk of corrosion
- When 10 to 50 kΩcm                 Moderate risk of corrosion
- When ≤ 10 kΩcm                      High risk of corrosion

Equipment used was a Proceq Resipod

**Approved By:**

**Signature:**

Lukasz Zalewski  
Field Service Manager

For and On Behalf of BHP Laboratories

Issue Date:

12/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

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# DETERMINATION OF RESISTIVITY OF CONCRETE



BHP/MTIField/F048 V1 30/04/24

**Client:** TRIUR Construction Ltd  
 13 Society Street  
 Ballinasloe  
 Galway

**FAO:** Lurcan Donnellan

**BHP Ref. No.:** 24/07/055-2  
**Order No:** Not Supplied  
**Date Tested:** 05/07/2024  
**Test Specification:** Client Spec.  
**Material** Concrete Element

**Project:** Mayo Bridges - Knockavrony Bridge  
**Location Reference:** Area 5  
**Test Standard:** EN 12390-19 2021

RESULTS				
Structural Element	Soffit			
Measurement Mode	Surface			
Contact Spacing	50mm			
Specimen Shape	Flat			
Dimensions of Test Area (mm)	400x400			
Minimum Measurement (kΩcm)	266			
Maximum Measurement (kΩcm)	285			
Mean Value (kΩcm)	273			
Interpretation of Result	Negligible risk of corrosion			
Resistivity Measurements (kΩcm)				
<b>274</b>	<b>272</b>	<b>270</b>	<b>285</b>	<b>266</b>
<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>

**REMARKS:**

Resistivity measurements can be used to estimate the likelihood of corrosion. When the electrical resistivity of the concrete is low, the likelihood of corrosion increases. When the electrical resistivity is high, the likelihood of corrosion decreases.

A guide to interpretation of resistivity results is:

- When ≥ 100 kΩcm                      Negligible risk of corrosion
- When 50 to 100 kΩcm                Low risk of corrosion
- When 10 to 50 kΩcm                 Moderate risk of corrosion
- When ≤ 10 kΩcm                      High risk of corrosion

Equipment used was a Proceq Resipod

**Approved By:**

**Signature:**

Lukasz Zalewski  
 Field Service Manager

For and On Behalf of BHP Laboratories

Issue Date:

12/08/2024

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# DETERMINATION OF RESISTIVITY OF CONCRETE



BHP/MTIField/F048 V1 30/04/24

**Client:** TRIUR Construction Ltd  
13 Society Street  
Ballinasloe  
Galway

**BHP Ref. No.:** 24/07/055-3  
**Order No:** Not Supplied  
**Date Tested:** 05/07/2024  
**Test Specification:** Client Spec.  
**Material** Concrete Element

**FAO:** Lurcan Donnellan

**Project:** Mayo Bridges - Knockavrony Bridge  
**Location Reference:** Area 4  
**Test Standard:** EN 12390-19 2021

RESULTS				
Structural Element	Soffit			
Measurement Mode	Surface			
Contact Spacing	50mm			
Specimen Shape	Flat			
Dimensions of Test Area (mm)	400x400			
Minimum Measurement (kΩcm)	204			
Maximum Measurement (kΩcm)	225			
Mean Value (kΩcm)	213			
Interpretation of Result	Negligible risk of corrosion			
Resistivity Measurements (kΩcm)				
<b>204</b>	<b>212</b>	<b>225</b>	<b>209</b>	<b>215</b>
<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>

**REMARKS:**

Resistivity measurements can be used to estimate the likelihood of corrosion. When the electrical resistivity of the concrete is low, the likelihood of corrosion increases. When the electrical resistivity is high, the likelihood of corrosion decreases.

A guide to interpretation of resistivity results is:

- When ≥ 100 kΩcm                      Negligible risk of corrosion
- When 50 to 100 kΩcm                Low risk of corrosion
- When 10 to 50 kΩcm                 Moderate risk of corrosion
- When ≤ 10 kΩcm                      High risk of corrosion

Equipment used was a Proceq Resipod

**Approved By:**

**Signature:**

Lukasz Zalewski  
Field Service Manager

For and On Behalf of BHP Laboratories

Issue Date:

12/08/2024

Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie

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# Appendix F. Structure Idealisation Model and Model Inputs

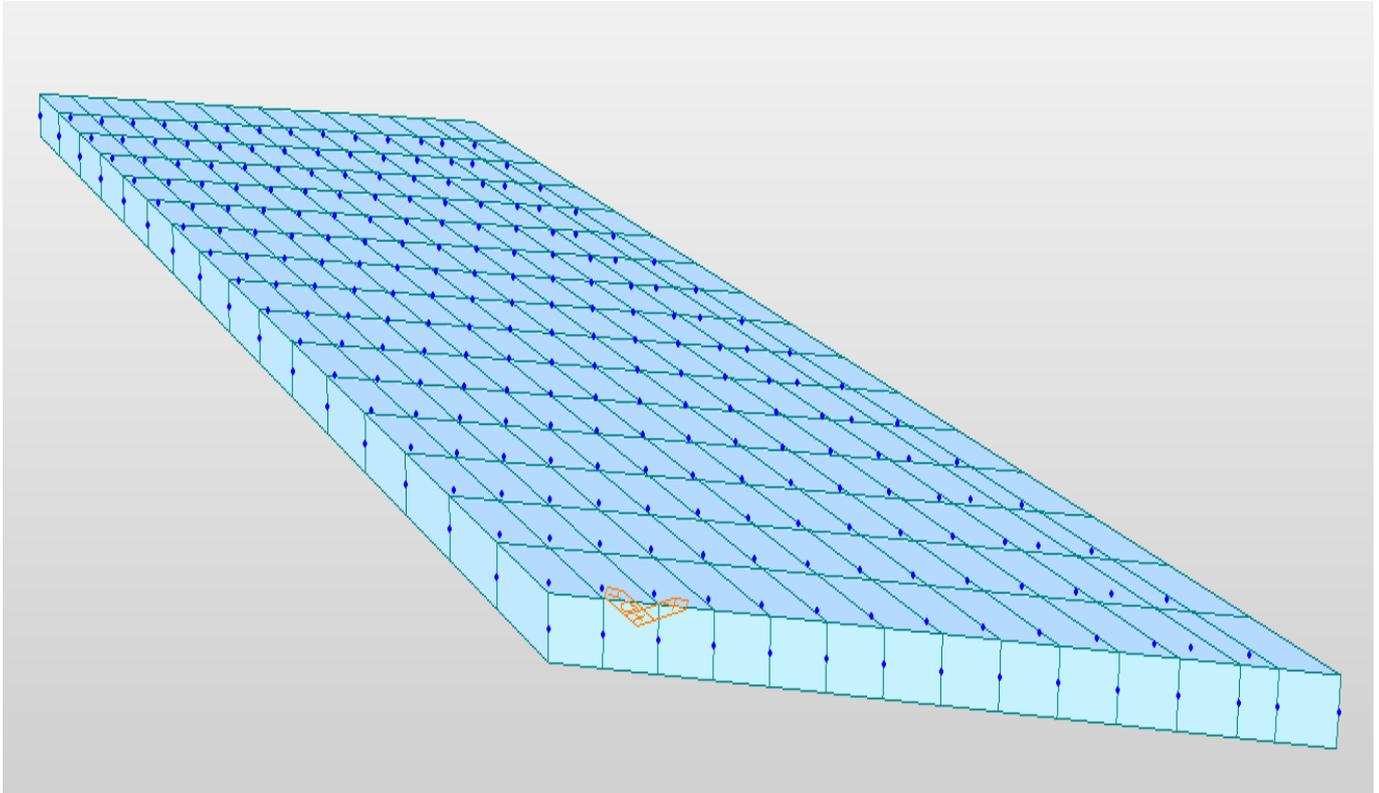


Figure F-1 – 3D Isometric view of the proposed model

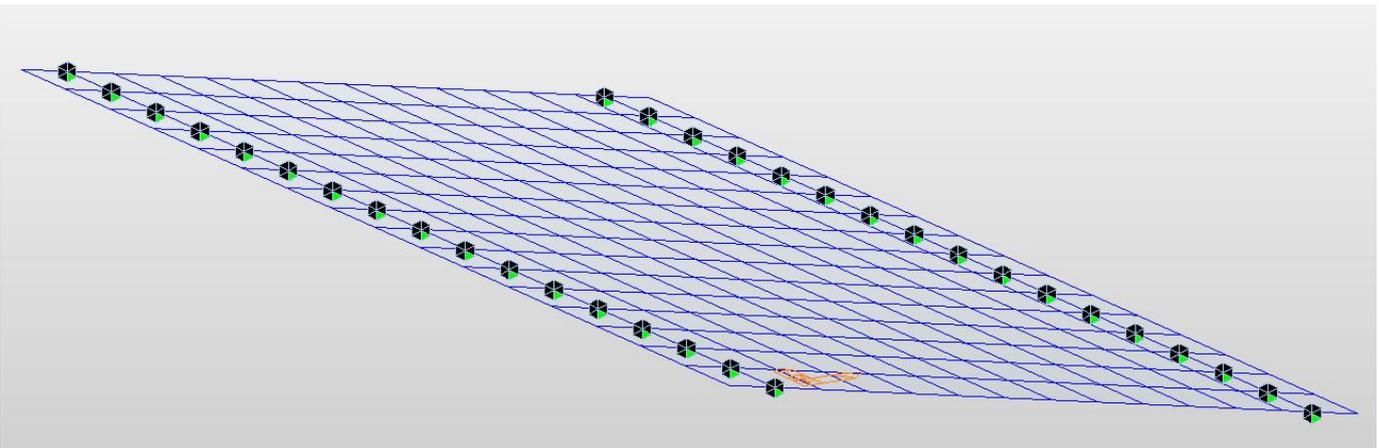


Figure F-2 – Model with support condition



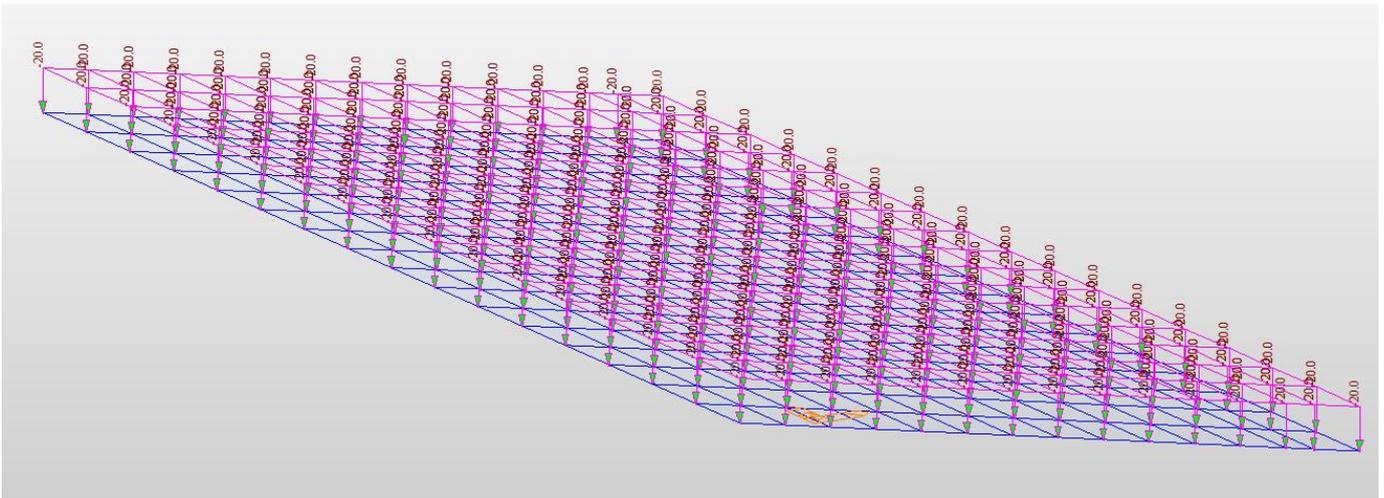


Figure F-3 – Soil weight load applied as pressure load

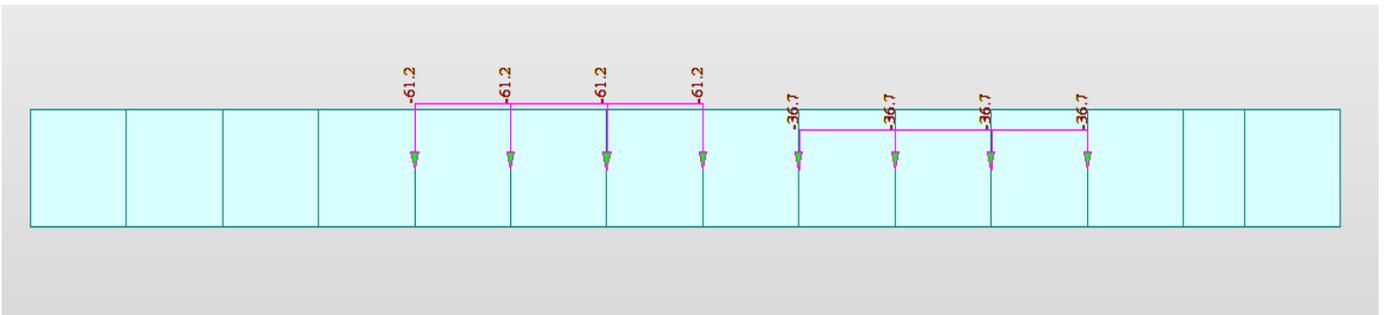


Figure F-4 - Accidental Wheel Load application



# Appendix G. Calculations



	<b>Project name</b>		<b>MAYO BRIDGE ASSESSMENTS 2024- EIRSPAN TASK ORDER 315</b>			<b>Job reference</b>											
	<b>Part of Structure</b>		<b>Knockavrony Bridge - MO-N05-013.00</b>			10088572											
	RC slab					Sheet no.	Rev										
	<b>Drawing Ref</b>		Assessment carried out using BD21/14	<b>Calc By</b>	<b>Date</b>	<b>Check by</b>	<b>Date</b>										
	-			VP	19-Nov-24	MG	19/11/2024										
Ref	Calculations					Output											
<p><b>1 Introduction</b></p> <p>1.1 Spreadsheet Purpose Stage 2 Assessment Calculations of RC Slab Bridge.</p> <p>1.2 Limitations There is no clear Data about the Foundation of the structure.</p> <p><b>2 Instructions for use</b></p> <p>2.1 The Assessment is based on TII Publications AM-STR-06056 Stage 1 Structural Assessment of Road Structures and AM-STR-06057 The Stage 2 Structural Assessment of Sub-Standard Road Structures.</p>																	
<p><b>3 Updates</b></p> <p>3.1 Previous Updates</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Revision</th> <th>Date</th> <th>Made By</th> <th>Checked</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>R0</td> <td>19-Nov-24</td> <td>VP</td> <td>MG</td> <td></td> </tr> </tbody> </table>								Revision	Date	Made By	Checked	Description	R0	19-Nov-24	VP	MG	
Revision	Date	Made By	Checked	Description													
R0	19-Nov-24	VP	MG														

	<b>Project Name</b>	MAYO BRIDGE ASSESSMENTS 2024-EIRSPAN TASK ORDER 315			<b>Job Number</b>	
					10088572	
	<b>Part of the Structure</b>	Structure ID-MO-N05-013.00 Knockavrony Bridge			<b>Sheet Number</b>	<b>Rev.</b>
	RC Slab				2 of 8	1
<b>Drawing Reference</b>	Assessment carried out using BD21/14	<b>Originator</b>	<b>Date</b>	<b>Checker</b>	<b>Date</b>	
-		VP	Nov-24	MG	Nov-24	

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<b>5 Load Calculation</b>	
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<b>7 Section Capacity at Midspan (Sagging Moment)</b>	
<b>8 Section Capacity Near Support (Sagging Moment)</b>	
<b>9 Finite Element Analysis Results</b>	

<b>Project Name</b> MAYO BRIDGE ASSESSMENTS 2024-EIRSPAN TASK ORDER 315 <b>Part of the Structure</b> RC Slab <b>Drawing Reference</b> -	<b>Job Number</b> 10088572			
	Structure ID-MO-N05-013.00 Knockavrony Bridge			
	<b>Sheet Number</b> 3 of 8	<b>Rev.</b> 1		
	<b>Assessment carried out using</b> BD21/14	<b>Originator</b> VP	<b>Date</b> Nov-24	<b>Checker</b> MG

Ref.	Calculations
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1  
  
AM-STR-06057

**General**

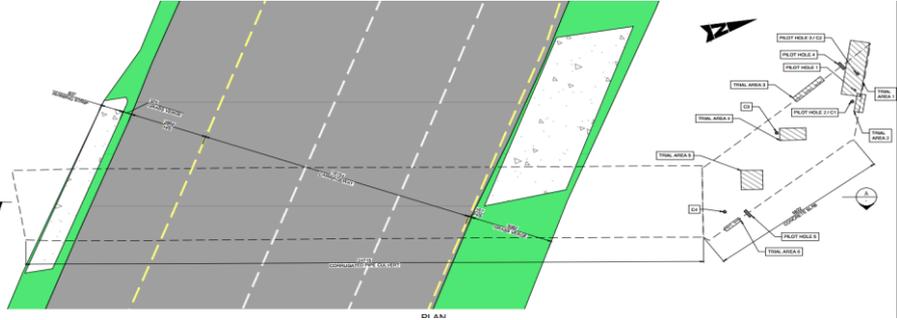
The concrete slab assessment was carried out in accordance with AMSTR-06031 and Chapter 2 of AM-STR-06026, unless superseded by a particular requirement of this Standard. For the stage 2 assessment the structure was modelled as Plate elements using FEM software Midas Civil as per TII AM-STR-06057.

2

**Introduction**

- \* **The structure is a Slab Bridge**
- \* The bridge clear span ( Square Dimen from Topo Survey) = 2.60 m
- \* Skew clear span = 3.99 m
- \* No of span = 1
- \* The effective skew span of the culvert (Simply supported) = 4.26 m
- \* The averaget thickness of Top Slab is (From SI Report) = 0.27 m
- \* Width of the concrete slab (From Topo Survey ) = 7.50 m
- \* Skew. Angle of concrete slab = 40 degree
- \* Average depth of Soil Fill = 1.00 m

( No vehicular load is acting on the concrete slab since the slab lies outside of the carriageway )



3

**Material parameters**

Element	$f_{ck}$ (N/mm <sup>2</sup> )
RCC Slab	46.6

Grade of steel  $f_y$  250 N/mm<sup>2</sup>

Density of reinforced concrete 25.0 kN/m<sup>3</sup>

Density of Structural fill 20.0 kN/m<sup>3</sup>

	<b>Project Name</b>	MAYO BRIDGE ASSESSMENTS 2024-EIRSPAN TASK ORDER 315			<b>Job Number</b> 10088572	
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	RC Slab				3 of 8	1
	<b>Drawing Reference</b>	Assessment carried out using BD21/14	<b>Originator</b>	<b>Date</b>	<b>Checker</b>	<b>Date</b>
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Ref.

Calculations

**Partial Safety Factors**AM-STR-06030  
Table 1

For reinforced concrete, the values of  $\gamma_m$  is taken as 1.2 considering worst credible strengths which is taken from Table 4A (4.3.3.3.) of AM-STR-06031. For Reinforcing Steel the  $\gamma_m$  is taken as 1.15.

**Appendix A**  
**Composite Version of BS 5400: Part 2**

**Volume 1 Section 3**  
**Part 14 BD 37/01**

**Table 1. Loads to be taken in each combination with appropriate  $\gamma_m$ .**

ULS: ultimate limit state

SLS: serviceability limit state

Clause number	Load	Limit state	$\gamma_m$ to be considered in combination				
			1	2	3	4	5
5.1	Dead: steel	ULS* SLS	1.05 1.00	1.05 1.00	1.05 1.00	1.05 1.00	1.05 1.00
	concrete	ULS* SLS	1.15 1.00	1.15 1.00	1.15 1.00	1.15 1.00	1.15 1.00
5.2	Superimposed dead: deck surfacing	ULS+ SLS+	1.75 1.20	1.75 1.20	1.75 1.20	1.75 1.20	1.75 1.20
	other loads	ULS SLS	1.20 1.00	1.20 1.00	1.20 1.00	1.20 1.00	1.20 1.00
5.8	Earth pressure: retained fill and/or live load	ULS SLS	1.20 1.00	1.20 1.00	1.20 1.00	1.20 1.00	1.20 1.00
	non-vertical loads	ULS SLS	1.50 1.00	1.50 1.00	1.50 1.00	1.50 1.00	1.50 1.00
	relieving effect	SLS	1.00	1.00	1.00	1.00	1.00
5.9	Erection: temporary loads	ULS SLS		1.15 1.00	1.15 1.00		
6.2	Highway bridges live loading: HA alone	ULS SLS	1.50 1.20	1.25 1.00	1.25 1.00		
6.3	HA with HB or HB alone	ULS SLS	1.30 1.10	1.10 1.00	1.10 1.00		
6.5	footway and cycle track loading	ULS SLS	1.50 1.00	1.25 1.00	1.25 1.00		
6.6	accidental wheel loading**	ULS SLS	1.50 1.20				

\* $\gamma_m$  shall be increased to at least 1.10 and 1.20 for steel and concrete respectively to compensate for inaccuracies when dead loads are not accurately assessed.

+ $\gamma_m$  may be reduced to 1.2 and 1.0 for the ULS and SLS respectively subject to approval of the appropriate authority (see 5.2.2.1).

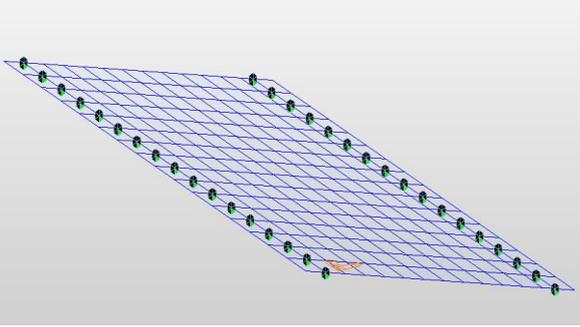
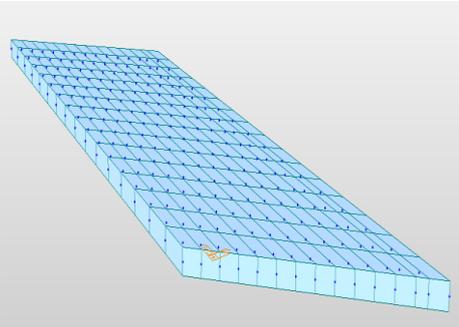
\*\*Accidental wheel loading shall not be considered as acting with any other primary live loads.

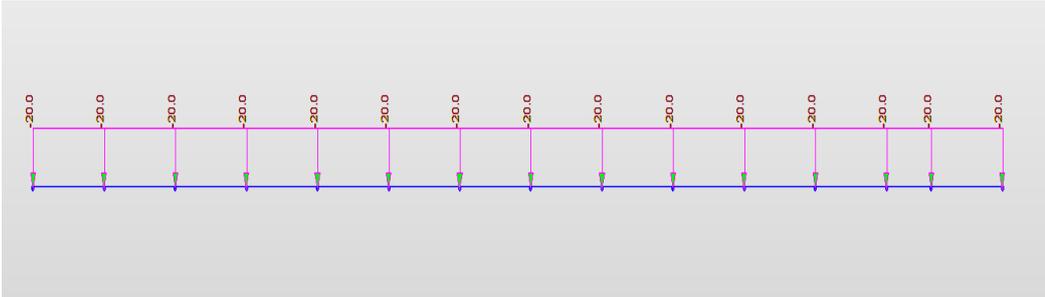
**Partial Safety Factors for RC Slab Assessment**

Load	$\gamma_f$ for ULS	$\gamma_{fL}$ for ULS
Dead Load	1.1	1.15
Super Imposed Dead Load	1.1	1.75
Soil Fill	1.1	1.2
Horizontal Earth Pressure	1	1
Type HA Loading	1.1	1.5
Type HB	1.1	1.3
SV 196	1.1	1.1

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	RC Slab				3 of 8	1
	<b>Drawing Reference</b>	Assessment carried out using BD21/14	<b>Originator</b>	<b>Date</b>	<b>Checker</b>	<b>Date</b>
-		VP	Nov-24	MG	Nov-24	

Ref.	Calculations
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4	<p><b>Model</b></p> <p>The concrete slab structure was assumed to be simply supported and will be analysed as a plate model in Midas Civil. 3D Plate Model</p> <div style="display: flex; justify-content: space-around;">   </div>
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5	<p><b>Load Calculation</b></p> <p><b>Dead Load</b> Sections are defined in Midas and material property are defined .Self Weight is applied in the Midas.</p> <p><b>Soil Fill</b></p> <table style="margin-left: 40px;"> <tr> <td>Existing fill (Embankment)</td> <td>=</td> <td>20.0 kN/m3</td> </tr> <tr> <td>Unit Weight of Soil Fill</td> <td>=</td> <td>1.00 m</td> </tr> <tr> <td>Depth of fill</td> <td>=</td> <td>20.00 kN/m</td> </tr> </table> <div style="text-align: center; margin: 10px 0;">  </div> <p><b>Surfacing</b> <i>Not used since the slab lies outside of carriageway.</i></p> <table style="margin-left: 40px;"> <tr> <td>Weight of Surfacing - 100 mm thick</td> <td>=</td> <td>1.00 x 0.1 x 1 x 24.0</td> </tr> <tr> <td>Surfacing depth</td> <td>=</td> <td>2.40 kN/m</td> </tr> </table> <p>(assumed as per BD21/14 (AM-STR-06026), cl 3.8 if no HTA info)</p> <p style="text-align: center; margin-top: 10px;"><i>(Since the concrete slab lies outside of the carriageway, the Accidental wheel is to be considered)</i></p>	Existing fill (Embankment)	=	20.0 kN/m3	Unit Weight of Soil Fill	=	1.00 m	Depth of fill	=	20.00 kN/m	Weight of Surfacing - 100 mm thick	=	1.00 x 0.1 x 1 x 24.0	Surfacing depth	=	2.40 kN/m
Existing fill (Embankment)	=	20.0 kN/m3														
Unit Weight of Soil Fill	=	1.00 m														
Depth of fill	=	20.00 kN/m														
Weight of Surfacing - 100 mm thick	=	1.00 x 0.1 x 1 x 24.0														
Surfacing depth	=	2.40 kN/m														

	<b>Project Name</b>	MAYO BRIDGE ASSESSMENTS 2024-EIRSPAN TASK ORDER 315		<b>Job Number</b> 10088572		
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	RC Slab				3 of 8	1
	<b>Drawing Reference</b>	Assessment carried out using BD21/14	<b>Originator</b>	<b>Date</b>	<b>Checker</b>	<b>Date</b>
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Ref.	Calculations
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CL 5.35  
AM-STR-06026  
BD21/14

**Accidental Wheel load**

Since the fill depth is 1m, the accidental wheel load is dispersed and applied on the slab at the critical position. Dispersed load is applied in the model as pressure loads.  
 Width of the Slab considered = 7  
 Number of lanes considered for RC slab = 1

Assessment Live Loading	W <sub>1</sub> (kN)	W <sub>2</sub> (kN)	a (m)
40 tonnes	100	60	1.5
26 tonnes	100	40	1.5
18 tonnes	100	10	1.5
7.5 tonnes	50	10	1.5
3 tonnes	25	-	-
FE Group One	60	10	1.5
FE Group Two	30	20	1.5

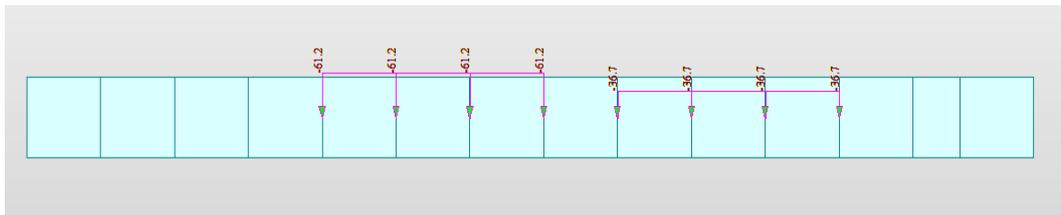


Table 5.4 Nominal Accidental Wheel Loads

**Accidental load**

Table 5.3.1 of  
BD21/14  
STR-06026

Assessment Loading	(Tonne)	W1	W2
Single wheel Load	(kN)	100.0	60.0
Wheel Contact Area	(m)	0.3	0.3
Depth of fill		1.0	1.0
Dispersion for one wheel, in longitudinal direction	leff	1.3	1.3
Dispersion for one wheel, in transverse direction	beff	1.3	1.3
Overlapping check transverse		No overlap	No overlap
Overlapping check Longitudinal traffic direct		No overlap	No overlap
$w = P/b_{eff} b_L$ assuming load dispersed long. & transversely	kN/m <sup>2</sup>	61.2	36.7
Yfl		1.5	1.5







<b>Project Name</b>	MAYO BRIDGE ASSESSMENTS 2024-EIRSPAN TASK ORDER 315		<b>Job ref</b> 10088572		
	<b>Part of Structure</b>	Structure ID-MO-N05-013.00 Knockavrony Bridge		<b>Calc sheet no. Rev</b>	
		RC Slab	Assessment carried out using BD21/14		5 of 8
	<b>Drawing Ref</b>	<b>Calc By</b>	<b>Date</b>	<b>Check by</b>	<b>Date</b>
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### CALCULATION OF WORST CREDIBLE STRENGTH

Input a maximum of 11 Core samples

App.C2  
SI Report

LOCATION	CORE REFERENCE	ESTIMATED IN-SITU CUBE STRENGTH N/mm <sup>2</sup> (f <sub>c</sub> )	(f <sub>c</sub> - MEAN) <sup>2</sup>
Slab	C1	46.6	14.25
	C2	52.2	3.33
	C3	53.7	11.06
	C4	49.0	1.89
			-
			-
			-
			-
			-
			-
<b>TOTAL</b>		201.5	30.53
<b>No of cores</b>		4	
<b>MEAN</b>		50.38	
<b>Standard Deviation</b>		3.19	

WCS will be calculated using 2 different methods:

1) **LOCATION** : Using equation from BA 44/96 with n = total number of core samples

**Note** - only use this for cores taken at the location of interest

$$n = 4$$

$$\text{From BA 44/90, } WCS = (\text{Total } f_c \cdot (100 - (20/n^{0.5}))) / 100n$$

$$WCS = 45.3 \text{ N/mm}^2$$

2) **LOWEST CORE STRENGTH** :

$$\text{Lowest core strength} = 46.6 \text{ N/mm}^2$$

$$WCS = 46.6 \text{ N/mm}^2$$

Using the above results and engineering judgement,  
the proposed WCS = 45.3 N/mm<sup>2</sup>





<b>AtkinsRéalis</b>	<b>Project Name</b>	MAYO BRIDGE ASSESSMENTS 2024-EIRSPAN TASK ORDER 315			<b>Job Number</b>	
	<b>Part of Structure</b>	RC Slab			10088572	
	<b>Drawing Reference</b>	Assessment carried out using BD21/14	<b>Originator</b>	<b>Date</b>	<b>Sheet Number</b>	<b>Rev.</b>
	-	VP	Nov-24	8 of 8	1	
				<b>Checker</b>	<b>Date</b>	
				MG	Nov-24	

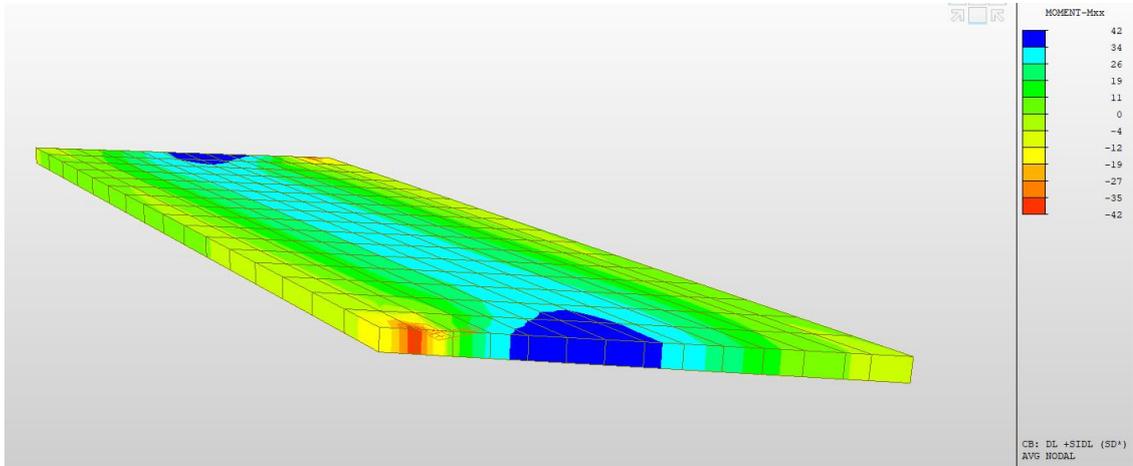
Ref.	Calculations	Output
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9

**Finite Element Analysis Results**

Dead Load + Super Imposed Dead load (SD\*)

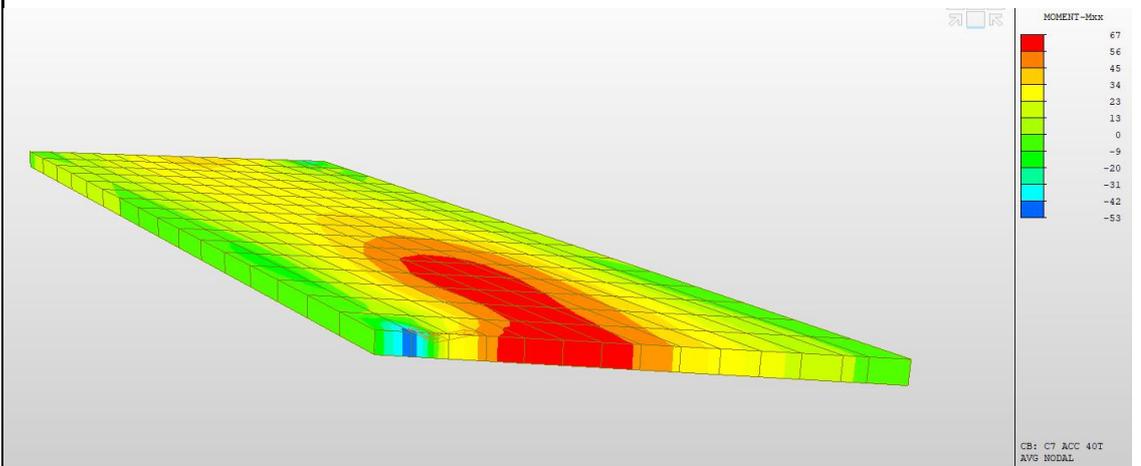
*Negligible Hogging moments are produced due to overhang of the slab over support.*



*Maximum of Moment along X axis ( Mxx)*  
 Moment near support = 11 kNm  
 Maximum Sagging Moment = 42 kNm  
 Maximum Shear = 150 kN

**Results Diagram - Accidental wheel Load**

Load effect due to Accidental Loading-ACC Case 1 (40T)



ACC Case 1  
(40T)  
*Maximum of Moment along X axis ( Mxx)*  
 Moment near support = 13 kNm  
 Maximum Sagging Moment = 67 kNm  
 Maximum Shear = 221 kN



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Ref.	Calculations	Output
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Assessment Summary Table.

Load Effect	RA*	SD*	ACC Case 1 (40T)
Moment near support (kNm)	85.3	11	13
RA*/SA*		7.8	6.6
Check		OK	OK
Max Sagging Moment (kNm)	85.3	42	67
RA*/SA*		2.0	1.27
Check		OK	OK
Maxm Shear (kN)	543.5	150	221
RA*/SA*		3.6	2.5
Check		OK	OK

Where

- RA\* = Assessment Resistance (flexure, shear etc.)
- SD\* = Assessment load effects due to dead and superimposed dead loads
- SHA\* = Assessment load effect due to the associated Type HA loading
- SHB\* = Load effect due to HB loading
- SA\* = Assessment load effects (Maximum of ULS Combination)
- RA\*/SA\* = Structural Assessment Factor (shown for the critical case from the ULS cases)

Element	Location in Structure	Load Effect	RA*	SD*	S <sub>ACC 40T*</sub>	RA*/SA*
Reinforced Concrete Slab	North Extension	Moment near Support (kNm)	85	11	13	6.6
		Max. Sagging Moment (kNm)	85	42	67	1.3
		Max. Shear (kN)	544	150	221	2.5

Structure ID	Structure Name	Structure Type	No. of Spans	Span Length	Accidental Loading
MO-N05-013.00	Knockavrony Bridge	RC Slab Bridge	1	3.99	40t

# Appendix H. Photographs



Photograph H-1 – View of the carriageway looking east



Photograph H-2 – View of the north rubbing strip



**Photograph H-3 – View of the south rubbing strip**



**Photograph H-4 – View of the north concrete parapet**



**Photograph H-5 – View of the south safety barrier**



**Photograph H-6 – View of the northeast embankment**



**Photograph H-7 – View of the southwest embankment**



**Photograph H-8 – View of the southwest wing wall**



**Photograph H-9 – View of the southeast wing wall**



**Photograph H-10 – View of the east concrete abutment**



**Photograph H-11 – View of the west concrete abutment**



**Photograph H-12 – View of the deck soffit looking south**



**Photograph H-13 – View of the spalling to the deck with exposed reinforcement**



**Photograph H-14 – View of the void to the headwall of the north elevation**



**Photograph H-15 – View of the spalling to the deck at the interface with the pipe with exposed corroded reinforcement evident**



**Photograph H-16 – View of the riverbed in the corrugated arch structure**



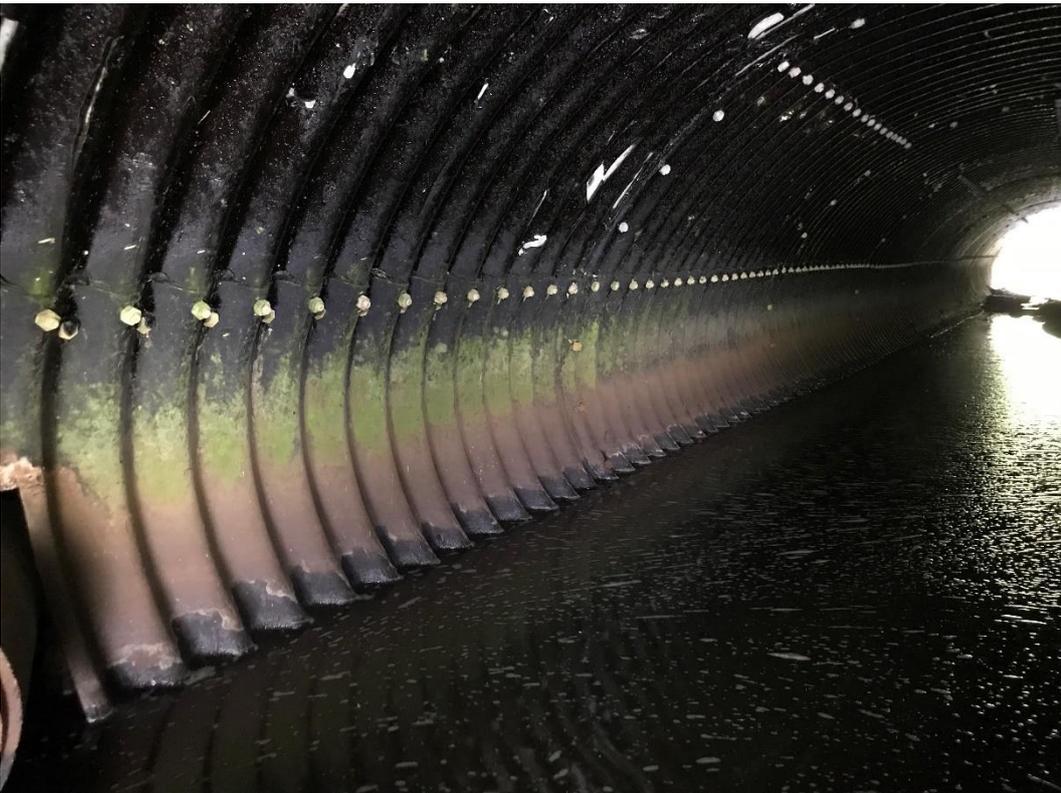
Photograph H-17 – View of the riverbed in the concrete slab section with scour evident



Photograph H-18 – View of the riverbed scour in the concrete deck extension



Photograph H-19 – View of the west side of the corrugated arch



Photograph H-20 – View of the east side of the corrugated arch



Photograph H-21 – View of the corrugated arch looking south



Photograph H-22 – View of the calcite forming around the bolts of the structure



**Photograph H-23 – View of the north elevation**



**Photograph H-24 – View of the south elevation**

**AtkinsRéalis**



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