

AtkinsRéalis



Stage 1 Structural Assessment Report

Mayo County Council

January 2025

N59 CARROWREVAGH BRIDGE REHABILITATION WORKS



Bonneagar Iompair Éireann
Transport Infrastructure Ireland



Comhairle Contae Mhaigh Eo
Mayo County Council

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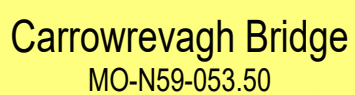
Contents

Location Map.....	1
Executive Summary.....	2
1. Introduction.....	4
2. Description of Structure	4
3. Visual Inspection of Structure	4
4. Site Investigations Results.....	6
5. Assessment of Structure	7
5.1 Arch Barrel	7
5.2 Reinforced Concrete Slab	8
6. Conclusions	10
7. Recommendations	11
Appendix A. List of Drawings & Sketches	
Appendix B. Inspection Photographs	
Appendix C. Site Investigation Results.....	
Appendix D. Calculations	
Appendix E. Sub-Standard Structure Summary	
Appendix F. Interim Measures Feasibility Assessment.....	

Tables

Table 5-1 - Arch dimensions used in the Assessment	7
Table 5-2 – Arch condition factors used in the Assessment	7
Table 5-3 - Slab dimensions used in the Assessment	8
Table 5-4 - Partial Safety Factors for Slab Assessment.....	9
Table 5-5 - Slab Assessment Live Load Capacity- Strip Method	9
Table 5-6 - Assessment Live Load Capacity - Finite Element Analysis	10
Table 6-1 - Summary of the Structural Assessment.....	11





Executive Summary

MO-N59-053.50 Carrowrevagh Bridge is a single span masonry arch structure extended to the north by a reinforced concrete slab carrying the N59 National Secondary Road over an unnamed river in Carrowkenedy, Co. Mayo. The masonry arch is formed of random rubble limestone masonry and has a span of 1.7m and a width out to out of 7.5m. The reinforced concrete slab measures 3.8m wide with a square span of 1.85m and a skew span of 1.92m. The overall width out to out of the structure is 11.2m.

The assessment of MO-N59-053.50 Carrowrevagh Bridge comprised a Stage 1 assessment of the masonry arch and reinforced concrete slab sections of the structure.

The inspection for assessment of the structure was undertaken in July 2024 with the structure in overall fair condition due to the masonry and pointing loss to the arch barrel and spalling with exposed reinforcement to the concrete deck. Structural investigations were undertaken to the masonry arch and reinforced concrete slab sections of the structure by TRIUR Construction Ltd. in July 2024 to inform the Stage 1 Assessment.

The structural assessment of the masonry arch barrel was undertaken using the modified MEXE method outlined in *AM-STR-06002 The Assessment of Road Bridges and Structures*. The Modified MEXE analysis gives a live load capacity of 40 tonnes Gross Vehicle Weight (GVW). In order to corroborate the results of the MEXE analysis further analysis using Archie-M software was undertaken as per the guidance given in *AM-STR-06026*. Archie-M analysis was carried out on the masonry arch for HA, HB and SV assessment loading. The Archie-M analysis determined a 3t HA loading capacity in the structure's current condition due to pointing loss with no capacity for SV and HB loading. The completion of repair and repointing works to the arch barrel gives an increased capacity of 40t HA loading, 30 units HB loading and SV196 SV loading for the masonry arch structure.

The reinforced concrete slab section of the structure was assessed in accordance with *AM-STR-06031 and AM-STR-06026*. As per the guidelines of *AM-STR-06056* a line beam analysis was first carried out for the reinforced concrete slab section. The structure was assessed using the strip method for HA loading, single axle and single wheel loads. The strip analysis resulted in a 40t GVW capacity with an HB capacity of 30 units and SV80 SV loading. A finite element analysis was also undertaken which confirmed adequate capacity for 40t HA loading, 45 units HB loading and SV196 SV loading.

Structure ID	Structure Name	Structure Type	No. of Spans	Span Length	Assessed Capacity (ALL)	HB Capacity	SV Capacity
MO-N59-053.50	Carrowrevagh Bridge	Masonry Arch	1	1.74m	3t	Fails 30 units	Fails SV80
		RC Slab	1	1.92m (sk)	40t	45 units	SV196

Based on the findings of the assessment no further assessment measures are deemed required for the structure, providing that the necessary repairs are undertaken to the arch barrel to return it to good condition. As there is no evidence of failure or excess deformation of the arch barrel, a load restriction is not recommended at this time however monitoring of the structure should be taken annually to check for any evidence of deformation or failure of the arch until the repairs are carried out. The future management of the structure should comprise principal inspections at regular intervals in accordance with *AM-STR-06039*.with term maintenance also undertaken to the structure to maintain its condition

The concrete spalling in the soffit of the deck should also be repaired, with the corroded reinforcement cleaned, treated with anti-corrosion paint, and the concrete cover reinstated. The recommended works for the structure are as follows:



- Improvement of vehicle and pedestrian containment measures across the structure
- Concrete repair to joint in north parapet
- Masonry repair to displaced east end of south parapet
- Vegetation clearance to the embankments to maintain a 1m access strip around the structure
- Extensive repointing to the masonry arch barrel using pinning stones where necessary
- Masonry repairs to the arch barrel
- Concrete repairs to 3no. areas of spalling to the concrete deck slab.
- Installation of a waterproofing membrane to the concrete deck slab.
- Removal of debris from the watercourse at the north elevation
- Repair of minor scour damage and associated undermining at the south elevation



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-N59-053.50 Carrowrevagh Bridge comprised a Stage 1 assessment of the masonry arch and reinforced concrete slab sections of the structure.

2. Description of Structure

MO-N59-053.50 Carrowrevagh Bridge is a single span masonry arch structure extended to the north by a reinforced concrete slab carrying the N59 National Secondary Road over an unnamed river in Carrowkennedy, Co. Mayo. The masonry arch is formed of random rubble limestone masonry and has a span of 1.7m and a width out to out of 7.5m. The reinforced concrete slab measures 3.8m wide with a square span of 1.85m and a skew span of 1.92m. The overall width out to out of the structure is 11.2m.

The bridge is carrying a 5.5m wide single carriageway with raised concrete rubbing strips located at both elevations of the structure. The rubbing strips on both sides of the structure measure 2.6m (north) and 1.8m (south) respectively. The parapets are of 450mm thick masonry construction to the south and 250mm thick concrete construction to the north and have a height of 600mm and 300mm respectively.

3. Visual Inspection of Structure

The inspection for the assessment of the structure was undertaken in July 2024 with photographs from the inspection provided in Appendix B of this report. Site investigation works were being carried out during inspection. The condition of the structure is as outlined below.

Bridge Surface

The carriageway is in good condition overall. See Photograph B-1 for a view looking west over the structure.

Footways

The recently installed rubbing strips are in good condition. See Photographs B-2 and B-3.

Parapets

The parapets are in good condition overall however both parapets are of substandard height. See Photograph B-4 for the north concrete parapet and Photograph B-2 for the south masonry parapet. Minor spalling and cracking has occurred around a construction joint in the west end of the north parapet, see Photograph B-5 and Photograph B-10



for the location of the joint. There is evidence of previous repointing repairs on the masonry parapet with the southeast corner of the masonry parapet showing 50mm outwards displacement approximately 1m in length, see Photograph B-6.

Embankments

The embankments at both elevations are stable and in good condition apart from minor vegetation growth. A service duct is running from the northeast embankment through the structure. See Photograph B-7 and B-8 for the northeast and southwest embankments.

Wing/Spandrel walls

The wing and spandrel walls are in good condition overall with minor vegetation growth noted at the southeast wing wall. See Photographs B-9 and B-10 for the southeast and northwest wing wall.

Abutments

The masonry abutments are in good condition with recent repointing repairs evident. The concrete abutments are in good overall condition with minor algae staining evident. See Photographs B-11 to B-14 for the abutments.

Deck

Arch Barrel

The masonry arch barrel is in fair condition with areas of masonry and pointing loss present. Despite the extensive pointing loss to the arch barrel no significant distortion or distress is noted to the arch profile with no cracking or other significant defects noted either. A summary of the defects is outlined below:

- Extensive pointing loss across the crown of the arch barrel with maximum depth of 250mm recorded.
- 3no. areas of missing masonry to the arch barrel
 - Area 1 – Inside the southern arch ring measuring 250mm x 230mm x 240mm
 - Area 2 – 0.5m in from the south elevation measuring 200mm x 140mm x 500mm
 - Area 3 – 3m in from the south elevation measuring 100mm x 120mm x 160mm
- Broken voussoir stone to the north elevation of the masonry arch.
- Cracked voussoir stones to the south elevation of the masonry arch.

See Photographs B-15 to B-22 for a view of the arch barrel and the defects outlined above.

Deck Slab

The reinforced concrete slab extension to the north end of the structure is in fair condition overall with 3no. areas of spalling to the concrete deck as follows.

- Area 1 – Inside northern fascia measuring 400mm x 100mm with exposed reinforcement
- Area 2 – 0.8m in from the north elevation measuring 0.7m x 0.3m with exposed reinforcement.
- Area 3 – At the southern end of the deck measuring 0.18m x 0.13m.

See Photographs B-23 to B-26 for a view of the concrete deck and the defects outlined above.

Riverbed

The riverbed below the structure is generally in good condition apart from a build-up of vegetation and debris noted at the northern elevation. Scour is also evident to the riverbed at the south end of the structure near the west



abutment measuring approximately 150mm deep over a length of 2m with 200mm deep undermining noted to the concrete apron. See Photographs B-27 to B-29.

Overall Structure

The structure is in an overall fair condition due to the masonry and pointing loss to the arch barrel and spalling with exposed reinforcement to the concrete deck. A review of the previous 2020 & 2024 Principal Inspection reports on the structure found no significant deterioration in the structure condition since the 2020 PI with routine maintenance undertaken since the 2020 inspection.

See Photograph B-30 and B-31 for a view of the north and south elevations of the structure.

4. Site Investigations Results

Structural investigations were undertaken to the structure by TRIUR Construction Ltd. in July 2024 to inform the Stage 1 Assessment and comprised the following:

Masonry Arch

- 2no. trial pits in concrete verges for depth of fill and deck/arch exposure
- 2no. pilot holes to arch crown (@ each elevation)
- 2no. radially drilled pilot holes above the arch springing (alternate left/right @ each elevation)

The trial pit to the footway over the masonry arch structure found a depth of fill of 290mm to the crown of the arch barrel from the footway surface with a clay material evident within the trial pit i.e. no backing found. The depth of fill above the carriageway was subsequently calculated as 180mm.

The pilot holes drilled through the crown of the arch found an arch thickness of 430mm and 470mm with the pilot holes above the springing finding an arch thickness of 415mm and 490mm. The pilot hole with the recorded depth of 415mm was found to be inconclusive due to the difficulty in confirming the end of the arch barrel construction with the thickness at springing unlikely to be less than that recorded at the crown of the arch. The 490mm measurement used therefore in the assessment.

Concrete Slab

- Covermeter & GPR survey to 4no. areas of deck slab with breakouts
- 4no. concrete cores and strength testing to soffit
- 3no. pilot holes to confirm deck thickness
- Durability testing to 3no. areas (1no. top, 1no. fascia, 1no. soffit)
- Waterproofing pull off testing to deck slab
- Covermeter & GPR survey to 2no. areas of abutments
- 2no. pilot holes to confirm abutment thickness
- Durability testing to 2no. areas of abutments

The trial pit to the concrete verge found a total depth of fill of 410mm which gives a depth of fill of 370mm below the carriageway with no waterproofing present on the deck slab. The pilot hole cores drilled through the deck measured



from 236mm to 253mm in depth. The reinforcement in the deck slab comprised 25mm longitudinal reinforcement at 160mm spacing and 12mm transverse reinforcement at 200mm spacing. The concrete strength of the slab varied between 56.2 N/mm² and 68.1N/mm². No reinforcement was found in either the top of the deck slab or the abutments with the support conditions assumed to be simply supported as a result.

See Appendix C of this report for further details of the structural investigations.

5. Assessment of Structure

A structural assessment in accordance with *AM-STR-06056 Stage 1 Structural Assessment of Road Structures* was undertaken to the structure in order to confirm the load carrying capacity of the structure.

Stage 1 assessment included the masonry arch and reinforced concrete slab sections of the structure.

5.1 Arch Barrel

A structural assessment of the masonry arch barrel was undertaken using the modified MEXE method outlined in *AM-STR-06002 The Assessment of Road Bridges and Structures*. The structure dimensions surveyed on site by Atkins and used in the assessment are listed below in Table 5-1.

Table 5-1 - Arch dimensions used in the Assessment

Span 1	Dimension (m)
Span	1.74
Rise at Crown	0.92
Rise at Quarter Point	0.81
Ring Thickness*	0.43
Depth of Fill	0.18

Based on a visual inspection and the recommendations of *AM-STR-06002* Annex D, the condition factors used in the arch assessment are summarised in Table 5-2 below.

Table 5-2 – Arch condition factors used in the Assessment

Condition Factor		Reasoning
Barrel Factor, F_b	1.0	Random rubble masonry in good overall condition
Fill Factor, F_f	0.7	Well-compacted clay material with no tracking evident to the carriageway
Joint Width Factor, F_w	0.8	Joint widths greater than 12.5mm
Joint Depth factor, F_d	0.589	100mm deep pointing loss, conservatively assumed across arch
Joint Mortar factor, F_{mo}	0.9	Friable mortar evident
Condition Factor, F_{cm}	0.8	Fair overall condition due to the areas of masonry loss. Extensive pointing loss included in other factors

The Modified MEXE analysis gives a live load capacity of 40 tonnes of Gross Vehicle Weight (GVW). As the structure is located on a straight horizontal and vertical alignment the structure was not assessed for centrifugal and lift-off effects.



The results from the MEXE analysis were corroborated with the results of the equilibrium analysis method using Archie-M software following the guidance given in AM-STR-06026. Archie-M analysis was carried out on the structure for HA, HB and SV assessment loading.

The Archie-M analysis carried out on the structure determined that the structure has a 3t HA loading capacity in its current condition due to pointing loss with no capacity for SV and HB loading. The structure in a good condition following completion of the repair works gives a capacity of 40t HA loading, 30 units HB loading and SV196 SV loading.

See Appendix D of this report for the calculations of MEXE and Archie-M analysis.

Abutments

A qualitative assessment was carried out for the masonry substructure elements with the abutments in good overall condition to support the arch barrel.

Parapet

A qualitative assessment was carried out on the masonry parapet in accordance with BS 6779-4. The masonry parapet is of substandard height and does not provide sufficient vehicle or pedestrian containment over the existing structure. The minor displacement to the east end of the south parapet is also noted although the cause is unknown.

5.2 Reinforced Concrete Slab

The reinforced concrete slab section of the structure was assessed in accordance with AM-STR-06031 and AM-STR-06026. As per the guidelines of AM-STR-06056 a line beam analysis was first carried out for assessment live loading comprising 40t HA loading in accordance with TII Publication AM-STR-06026. As a conservative measure the 1m strip of the slab was assumed to be subject to loading rather than the actual applied loading on the structure.

Abnormal loading was also considered as part of the assessment and comprised SV196 loading in accordance with TII Publication AM-STR-06048. *The Assessment of Road Bridges and Structures for the Effects of Abnormal and Exceptional Abnormal Load Vehicles using SV and SOV Load Models* and 45 Units HB loading in accordance with AM-STR-06030 *Loads for Highway Bridges*.

The structure dimensions used in the assessment are listed below in Table 5-3.

Table 5-3 - Slab dimensions used in the Assessment

	Dimension
No. Spans	1
Clear Span (square/skew)	1.92m (skew span)
Average Slab Thickness	0.246m
Width of Slab	3.84m
Width of carriageway	5.5m (0.38m on slab section)
Width kerb-to-kerb	5.9m (0.75m on slab section)
Skew angle	17°
Average depth of fill	0.27m
Depth of surfacing	0.1m



For concrete, the values of γ_m is taken as 1.2 considering worst credible strengths which is taken from Table 4A (4.3.3.3.) of AM-STR-06031. The partial safety factors taken from AM-STR-06030 Table 1 are shown below in Table 5-4.

Table 5-4 - Partial Safety Factors for Slab Assessment

Loading	γ_{f3} for ULS	γ_{fL} for ULS
Dead Load	1.1	1.15
Super Imposed Dead Load	1.1	1.75
Soil Fill	1.1	1.2
Type HA Loading	1.1	1.5
Type HB Loading	1.1	1.3
SV Loading	1.1	1.1

Due to visible defects near the north elevation, a condition factor of 0.9 was assumed in the assessment of the reinforced deck slab. The site investigations identified that the reinforcement bars in the deck slab are smooth bars which indicates mild steel, as a conservative measure a reduced steel strength of 230 N/mm² has been assumed for the purpose of assessment. The worst credible strength of concrete was taken as 54.5 N/mm². The structure was assessed using the strip method for HA loading, single axle and single wheel loads. The live load capacity of the RC deck slab was 40 tonnes Gross Vehicle Weight (GVW) in bending and 40T Gross Vehicle Weight (GVW) in shear. The results are summarised in Table 5-5 below.

Table 5-5 - Slab Assessment Live Load Capacity- Strip Method

Load Effect	HA UDL & KEL	Single Axle	Single Wheel	HB	SV
Moment	40t	40t	40t	30HB	SV80
Shear	40t	40t	40t	45HB	SV196

As per the table above the strip analysis resulted in a 40t GVW capacity with an HB capacity of 30 units and SV80 SV capacity.

Although any abnormal loads crossing the existing structure are likely to only cross the masonry arch section of the structure due to the narrow carriageway widths supported by the slab section, further confirmation of the HB and SV capacity was sought. A finite element analysis was undertaken by modelling the slab as plate elements in MIDAS Civil considering the actual structural behaviour with the transverse distribution of loads as per TII AM-STR-06057. Figure 5-1 below shows the 3-dimensional view of the model.

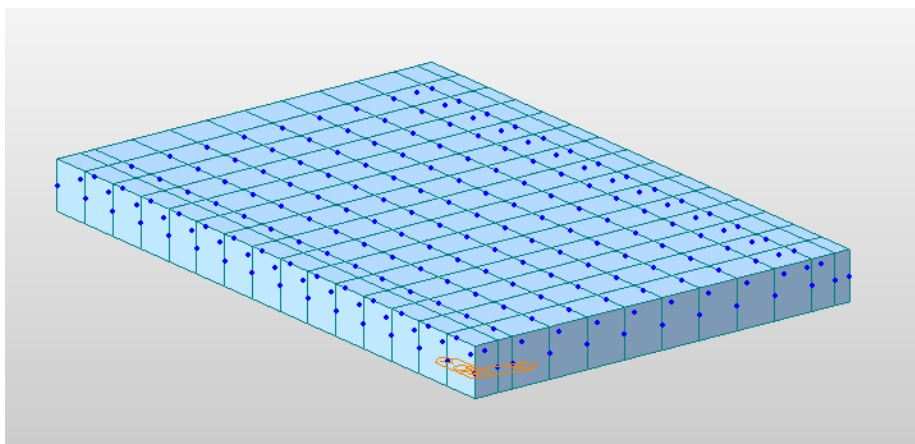


Figure 5-1 – Finite Element Model Idealization

As shown in the finite element analysis summary in Table 5-6 below the reinforced concrete slab was found to have a sufficient capacity of 40t HA loading, 45 units HB loading and SV196 SV loading.

Table 5-6 - Assessment Live Load Capacity - Finite Element Analysis

Element	Load Effect	R_A^*	S_D^*	S_{HA40t}^*	S_{HB45}^*	S_{SV196}^*	R_A^*/S_A^*
Reinforced Concrete Slab	Moment near Support (Sagging) (kNm)	83	5	12	19	18	4.3
	Max. Sagging Moment (kNm)	115	15	44	89	83	1.3
	Max. Shear (kN)	583	66	136	217	376	1.6

Where

- R_A^* = Assessment Resistance (flexure, shear etc.)
- S_D^* = Assessment load effects due to dead and superimposed dead loads
- S_{HA}^* = Assessment load effect due to the associated Type HA loading and Permanent loads (ULS)
- S_{HB}^* = Load effect due to HB loading and Permanent loads (ULS)
- S_{SV}^* = Load effect due to Special Vehicle loading and Permanent loads (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)

Abutments

A qualitative assessment was carried out for the concrete substructure elements with the abutments in good overall condition to support the reinforced concrete slab section.

Parapet

The concrete parapet is of substandard height and does not provide sufficient vehicle or pedestrian containment over the existing structure in accordance with BS 6779-2.

6. Conclusions

The masonry structure is in an overall fair condition due to the masonry and pointing loss to the arch barrel. The Archie-M and MEXE analysis carried out on the structure determined that the structure has a 3t load capacity in its current condition. Following the completion of the repairs outlined in section 7 below the capacity for the structure increases to 40t.

The reinforced concrete deck slab is in good condition overall apart from areas of spalling and exposed reinforcement at the north elevation. It has been determined to have sufficient capacity for full HA, HB and SV loading in its current condition however. The results are summarised in Table 6-1 below.



Table 6-1 - Summary of the Structural Assessment

Structure ID	Structure Name	Structure Type	No. of Spans	Span Length	Assessed Capacity (ALL)	HB Capacity	SV Capacity
MO-N59-053.50	Carrowrevagh Bridge	Masonry Arch	1	1.74m	3t	Fails 30 units	Fails SV80
		RC Slab	1	1.92m (sk)	40t	45 units	SV196

7. Recommendations

Based on the findings of the assessment no further assessment measures are deemed required for the structure, providing that the necessary repairs are undertaken to the arch barrel to return it to good condition. As there is no evidence of failure or excess deformation of the arch barrel, a load restriction is not recommended at this time however monitoring of the structure should be taken annually to check for any evidence of deformation or failure of the arch until the repairs are carried out.

The future management of the structure should comprise principal inspections at regular intervals in accordance with the requirements for Class 1 monitoring in *AM-STR-06039* with term maintenance also undertaken to the structure to maintain its condition.

The concrete spalling in the soffit of the deck should also be repaired, with the corroded reinforcement cleaned, treated with anti-corrosion paint, and the concrete cover reinstated. The recommended works for the structure are as follows:

- Improvement of vehicle and pedestrian containment measures across the structure
- Concrete repair to joint in north parapet
- Masonry repair to displaced east end of south parapet
- Vegetation clearance to the embankments to maintain a 1m access strip around the structure
- Extensive repointing to the masonry arch barrel using pinning stones where necessary
- Masonry repairs to the arch barrel
- Concrete repairs to 3no. areas of spalling to the concrete deck slab.
- Installation of a waterproofing membrane to the concrete deck slab.
- Removal of debris from the watercourse at the north elevation
- Repair of minor scour damage and associated undermining at the south elevation



Appendices

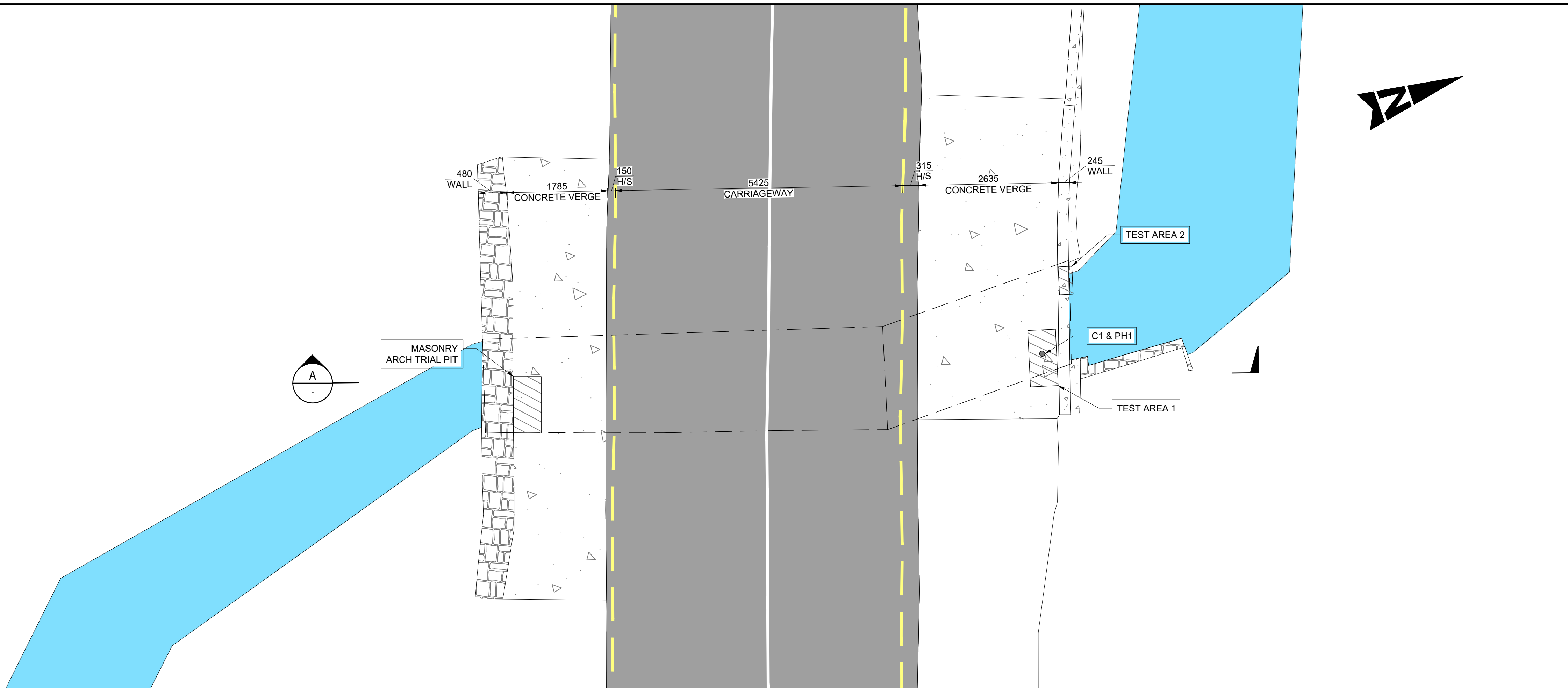
Appendix A. List of Drawings & Sketches



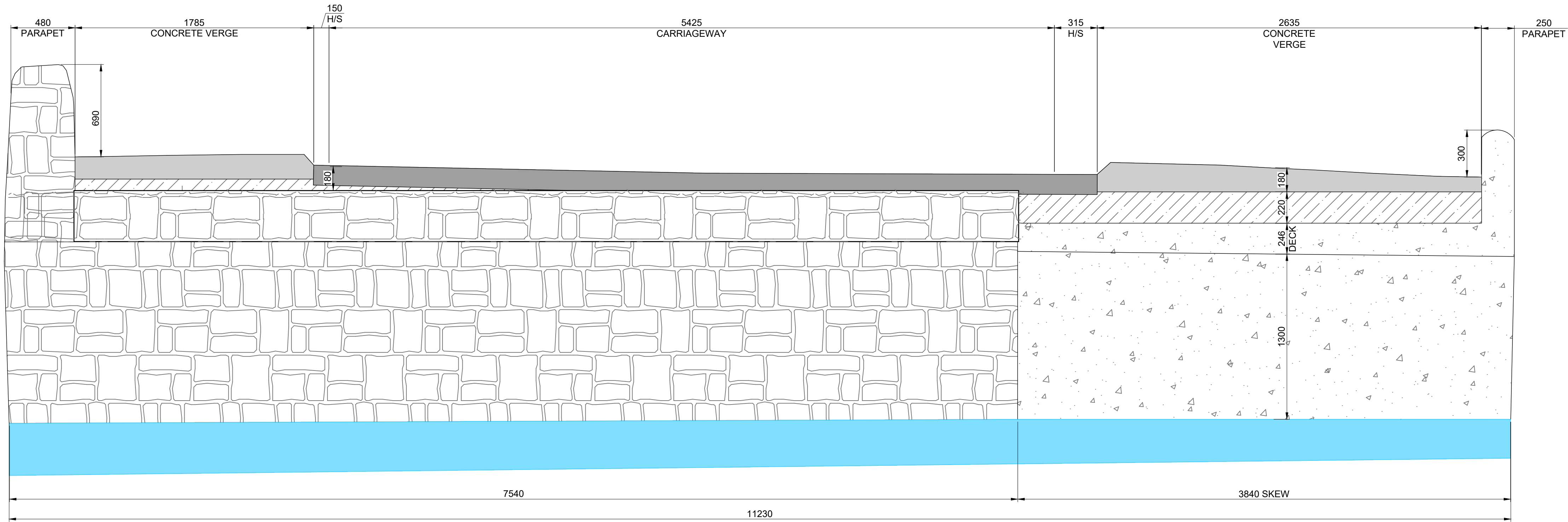
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PLAN
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SECTION A
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Scale at A3 1:40

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Purpose PRELIMINARY ISSUE

Title Carrowrevagh Bridge
MO-N59-053.50
PLAN AND CROSS SECTION

Original Scale	Drawn	Checked	POS	Reviewed	MG	Authorised	MJ
As Shown	Date 30.08.24	SOC	Date 30.08.24	POS	Date 30.08.24	MG	Date 30.08.24
Status	Drawing Number	Rev					
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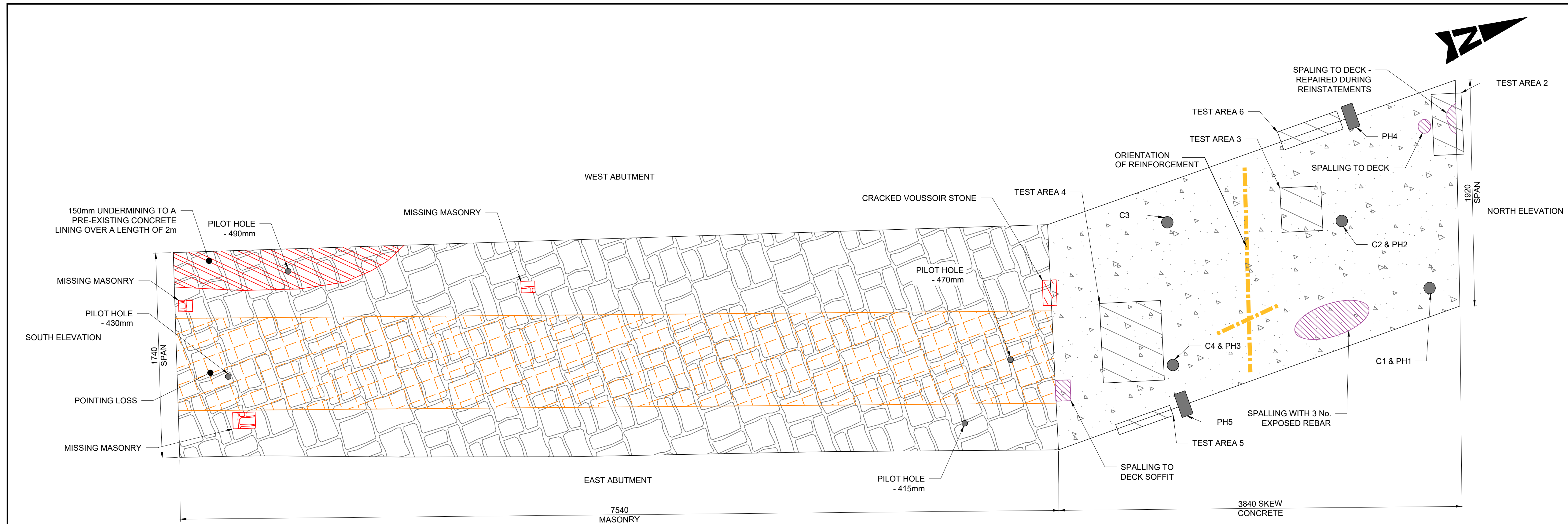


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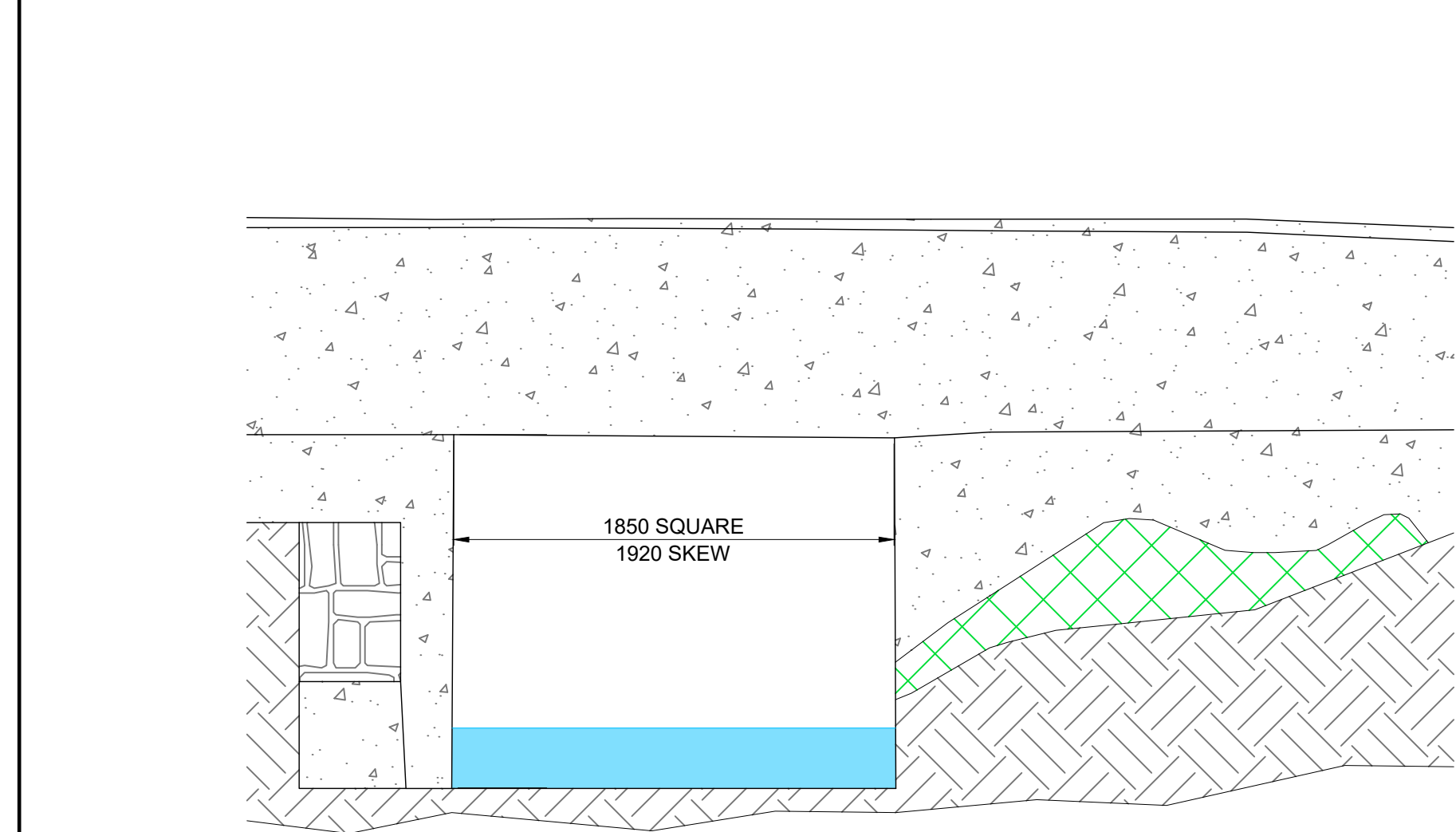
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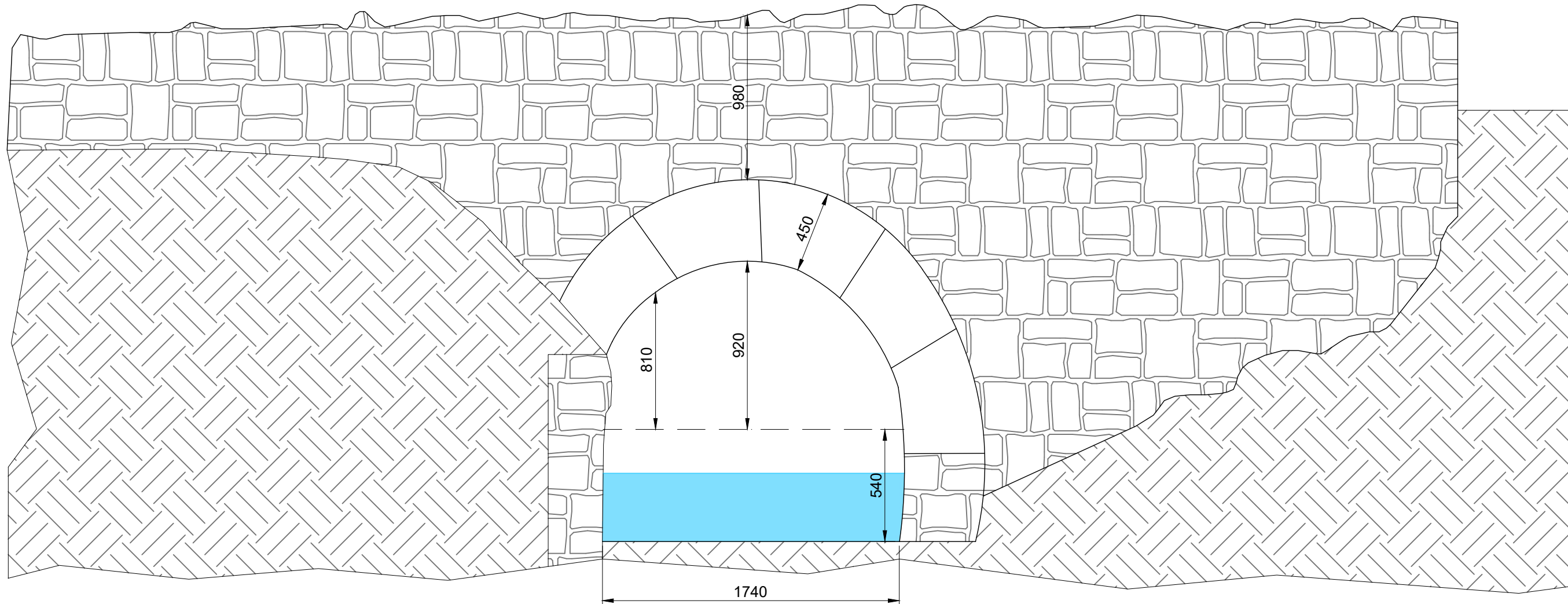
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DEFECT PLAN
Scale at A1 1:20
Scale at A3 1:40



NORTH ELEVATION
Scale at A1 1:25
Scale at A3 1:50



SOUTH ELEVATION
Scale at A1 1:25
Scale at A3 1:50

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Purpose		PRELIMINARY ISSUE	
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Comhairle Contae Mhaigh Eo
Mayo County Council

Project
TO315 - MAYO BRIDGE ASSESSMENTS AND STRENGTHENING 2023

Appendix B. Inspection Photographs



Photograph B-1 – View of the bridge surface looking west



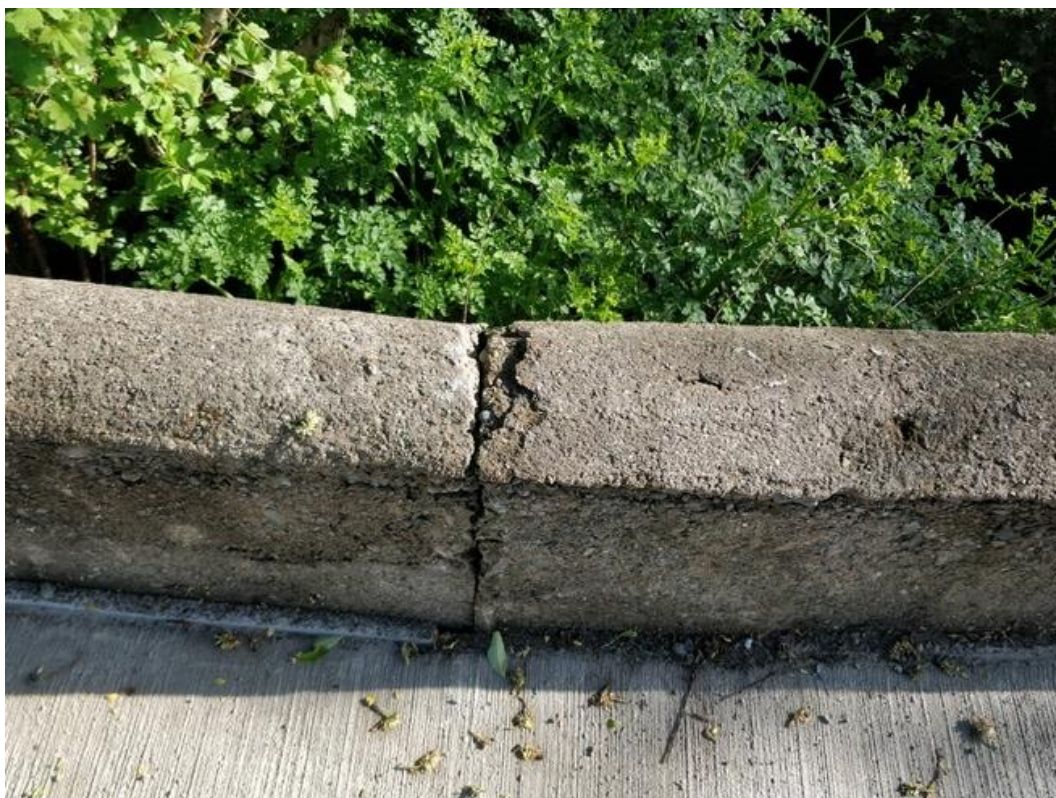
Photograph B-2 – View of the south rubbing strip and parapet



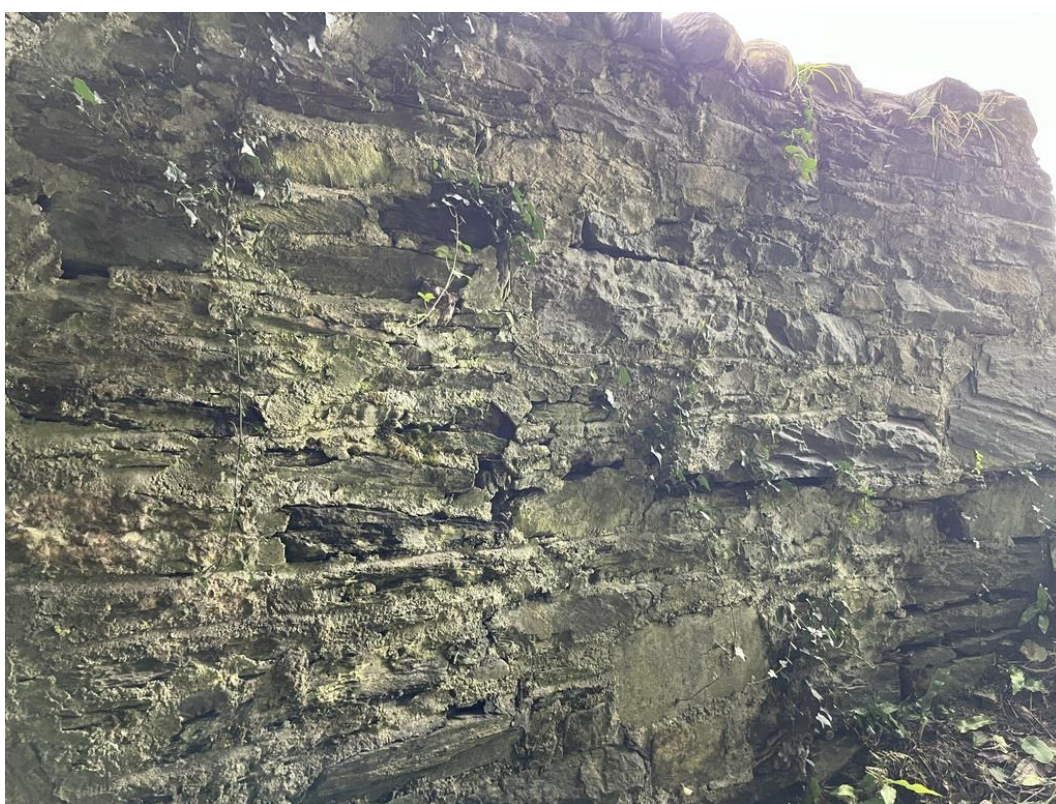
Photograph B-3 – View of the north rubbing strip



Photograph B-4 – View of the north concrete parapet



Photograph B-5 – View of the cracking at the joint in the concrete parapet



Photograph B-6 – View of the minor displacement noted to the east end of the south parapet



Photograph B-7 – View of the northeast embankment



Photograph B-8 – View of the southwest embankment



Photograph B-9 – View of the southeast wing wall



Photograph B-10 – View of the northwest wing wall



Photograph B-11 – View of the east masonry abutment



Photograph B-12 – View of the west masonry abutment



Photograph B-13 – View of the east concrete abutment



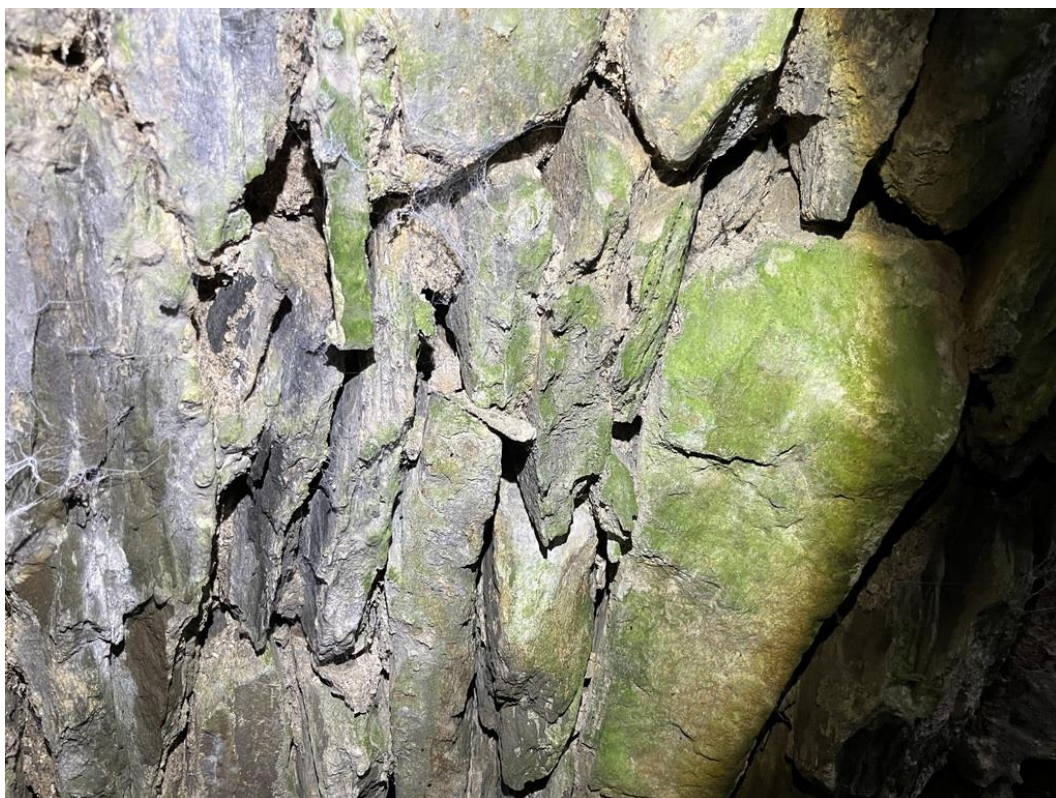
Photograph B-14 – View of the west concrete abutment



Photograph B-15 – View of the masonry arch barrel looking south



Photograph B-16 – View of the masonry arch barrel looking north



Photograph B-17 – View of the open joints to the masonry arch barrel



Photograph B-18 – View of the missing masonry to the arch barrel (Area 1)



Photograph B-19 – View of the missing masonry to the arch barrel (Area 2)



Photograph B-20 – View of the missing masonry to the arch barrel (Area 3)



Photograph B-21 – View of the cracked voussoir stone at the northern end of the arch barrel



Photograph B-22 – View of the cracked voussoir stone at the south elevation



Photograph B-23 – View of the concrete deck extension looking south



Photograph B-24 – View of the spalling to the concrete deck at the northern fascia (Area 1)



Photograph B-25 – View of the spalling to the concrete deck 0.8m from the north elevation (Area 2)



Photograph B-26 – View of the spalling to the concrete deck at the south end of the deck (Area 3)



Photograph B-27 – View of the river at the north elevation with debris evident



Photograph B-28 – View of the river at the south elevation of the structure



Photograph B-29 – View of the scour and undermining at the south end of the structure



Photograph B-30 – View of the north elevation



Photograph B-31 – View of the south elevation

Appendix C.Site Investigation Results





Structural Investigation Report

**MO-N59-053.50- STRUCTURAL INVESTIGATION REPORT
– [REV1]**

10TH NOVEMBER 2024

PREPARED FOR



Comhairle Contae Mhaigh Eo
Mayo County Council





CONTENTS

1.	INTRODUCTION.....	1
2.	GENERAL DESCRIPTION OF STRUCTURE	2
3.	INVESTIGATION WORKS.....	3
4.	INVESTIGATION RESULTS	4
5.	DETAILED SKETCHES	7
6.	PHOTO REPORT	
7.	APPENDIX 1 – LAYOUT DRAWING	
8.	APPEDNIX 2 – LAB TEST REPORT	

1. INTRODUCTION

TRIUR Construction LTD carried out structural investigation works on Carrowrevagh Bridge (MO-N59-053.50) from the 29nd to the 31st 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
- Excavation of 1no. trial pit in northern road verge for depth of fill and deck exposure.
- Excavation of 1no. trial pit in southern road verge for depth of fill and exposure of arch backing.
- Coring of 4no. samples for strength testing of deck soffit.
- The drilling of pilot holes in both the deck and the abutments, as required.
- The drilling of 2no. pilot holes in the arch crown of the masonry structure.
- The drilling of 2no. pilot holes in the arch springing of the masonry structure.
- 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 (if required) of Test area 1-5.
- 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 31st 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

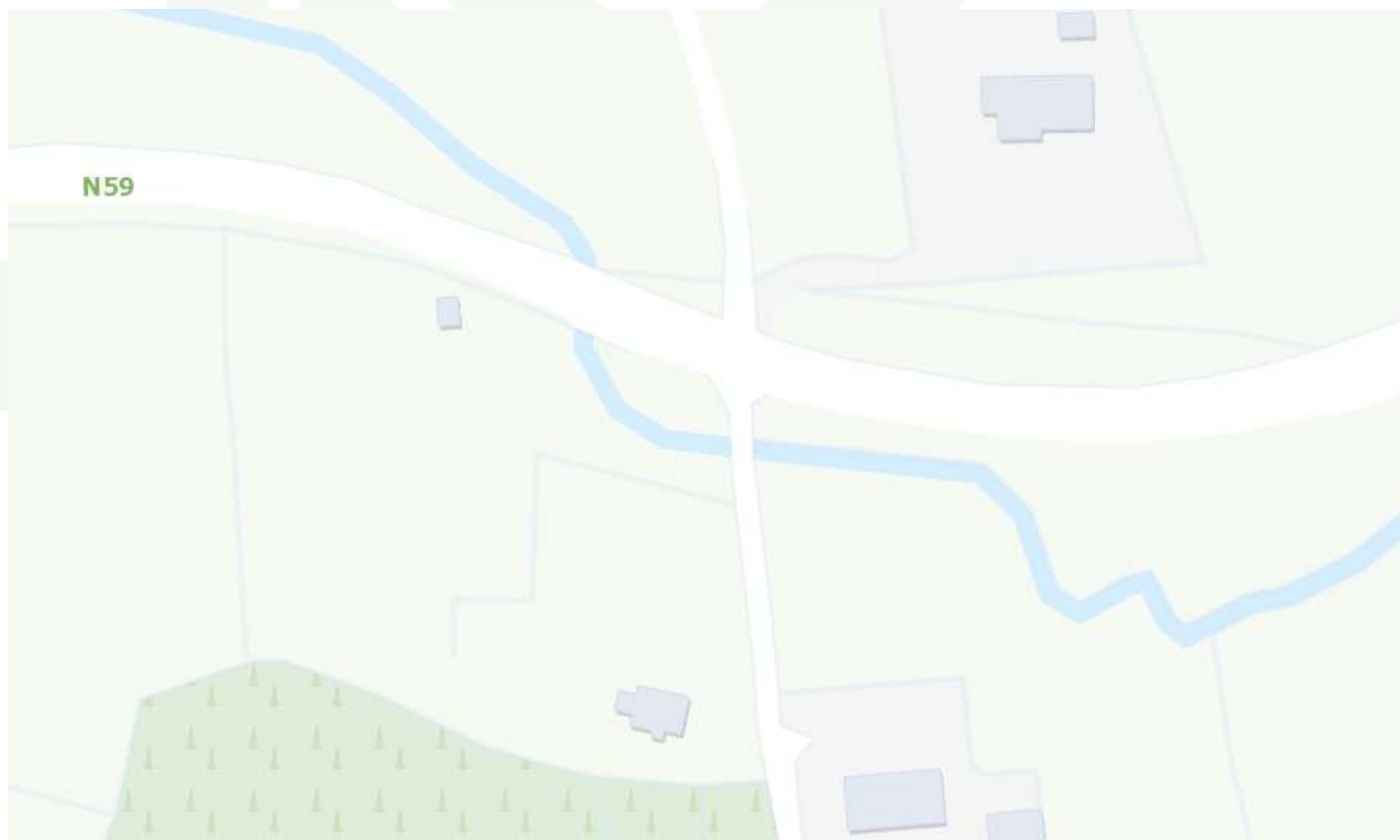
Carrowrevagh Bridge is a single span reinforced concrete bridge with a span of approx. 2m and a width of approx. 4m extended by the original masonry arch bridge to the south which has a width of 7.5m approx. It carries the N59 national secondary road over a minor stream which flows from north to south.

Location

Carrowrevagh Bridge

Co-ordinates: 53.710250, -9.558722

MO-N59-053.50, about 13km south of Westport



3. INVESTIGATION WORKS

- The excavation of 1no. Trial pit above the deck on the Northern verge (TP01) which comprised of the excavation of a layer of concrete rubbing strip and kerbing, followed by a layer of 804 covering the deck. Test area 1 (TA1) was located in this trial hole. A plastic sheet waterproofing layer was found between the fill and concrete rubbing strip. However, no waterproofing layer was uncovered above the concrete deck. Two service ducts were found in the trial pit running parallel with the direction of the road.
- The excavation of 1no. Trial pit above the arch on the Southern verge (TP02) which comprised of the excavation of a layer of concrete rubbing strip and kerbing followed by a layer of 804 covering the fill above the arch. A plastic sheet waterproofing layer was found between the fill and concrete rubbing strip. However, no waterproofing layer was uncovered above the concrete deck. Two service ducts were found in the trial pit running parallel with the direction of the road. A pilot hole was also drilled through the masonry at the rear of the keystone in order to get a measurement for the thickness of the arch.
- Reinforcement was found via breakouts in the soffit. Both longitudinal and transverse members were located and exposed on the soffit. No reinforcement was found directly below the top of the deck slab.
- The excavation of Test Area 01, located above the northern end of the deck slab. The trial pit was excavated to expose 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. The material covering this RC slab was observed to be Concrete and 804. A pilot hole, PH1 was drilled through the deck to obtain deck thickness in this area. A core sample C1 was also taken from the same location as the pilot hole PH1. Durability testing of the breakout area and adhesion testing of the deck was carried out by BHP.
- The investigation of a (Test Area 02), located in the northern fascia on the western side of the slab. In this Test Area, a Covermeter and GPR survey was conducted to the fascia. The scan indicated that there was no reinforcement present to a depth of approx. 200mm. A concrete breakout was then carried out to confirm the lack of reinforcement in the test area via the breakout of a 200mm deep opening in the fascia. Durability testing was carried out by BHP.
- The investigation of Test Area 03, located in the soffit approx. 800mm from the northern fascia. The area was scanned for reinforcement, samples acquired for testing and broken out to expose reinforcement. Core samples C1, C2, C3 and C4 were extracted from the soffit for lab strength testing. C1 was extracted from the TA1 beside the breakout area approx. 1m in from the northern fascia. C2 was extracted from the soffit approx. 1.2m from the northern fascia on the east side while C3 was extracted from the soffit at approx. 4m from the southern edge of the concrete structure. Both C1 and C2 acted as pilot holes and were drilled to the full depth of the deck in order to get a measurement for the thickness of the deck. A further two pilot holes were drilled at the south end of the concrete soffit in order to obtain a value for the thickness of the deck. Durability testing was carried out by BHP.
- The investigation of Test Area 04, located in the soffit approx. 700mm from southern end of the concrete structure. The area was scanned for reinforcement, samples acquired for testing and broken out to expose reinforcement.
- The investigation of Test area 5 located on the eastern abutment. In this area, a Covermeter and GPR survey was conducted to a 2m x 2m area. No reinforcement was found in the GPR survey and therefore no breakout was conducted. Durability testing was carried out by BHP. This was followed by the drilling of a pilot hole to obtain the abutment thickness in this location.
- The investigation of Test area 6 located on the western abutment. In this area, a Covermeter and GPR survey was conducted to a 2m x 2m area. No reinforcement was found in the GPR survey and therefore no breakout was conducted. Durability testing was carried out by BHP. This was followed by the drilling of a pilot hole to obtain the abutment thickness in this location.
- Adhesion pull off test was carried out on the deck top surface in Test Area 1 to determine the suitability of deck to a spray applied deck waterproofing system.

4. INVESTIGATION RESULTS

TEST AREA 1	mm
DECK (north verge)	
Depth of fill material	220
Depth of Concrete Verge	180
cover on longitudinal bars	n/a
cover on transverse bars	n/a
Longitudinal bar sizing	n/a
Transverse bar sizing	n/a
pilot hole 1	248
pilot hole 2	236
pilot hole 3	253
Core 1 – Top Deck	61.1 N/mm2
Core 2 Top Deck	56.6 N/mm2

TEST AREA 2	mm
FACIA (north)	
cover on bottom flange	n/a
side cover bottom flange	n/a
side cover on top flange	n/a
side cover on Web	n/a
<i>No reinforcement found</i>	

TEST AREA 3	mm
Soffit	
cover on longitudinal bars	14
cover on transverse bars	43
Longitudinal bar sizing	25
Transverse bar sizing	12
Core 3 - Soffit	68.1 N/mm2

Core 4 - Soffit	56.2 N/mm ²
-----------------	------------------------

TEST AREA 4	mm
Soffit	
cover on longitudinal bars	22
cover on transverse bars	48
Longitudinal bar sizing	25
Transverse bar sizing	12

TEST AREA 5	mm
East Abutment	
Pilot Hole	448
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>	

TEST AREA 6	mm
West Abutment	
Pilot Hole	682
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>	

Stone arch	mm
Depth of fill material	120-230
Depth of Concrete Verge	180
Pilot Hole North crown	470
Pilot Hole South crown	430
Pilot Hole East springing	415
Pilot Hole West springing	490
<i>No reinforcement found</i>	

5. DETAILED SKETCHES

Carrowrevagh Bridge- PLAN

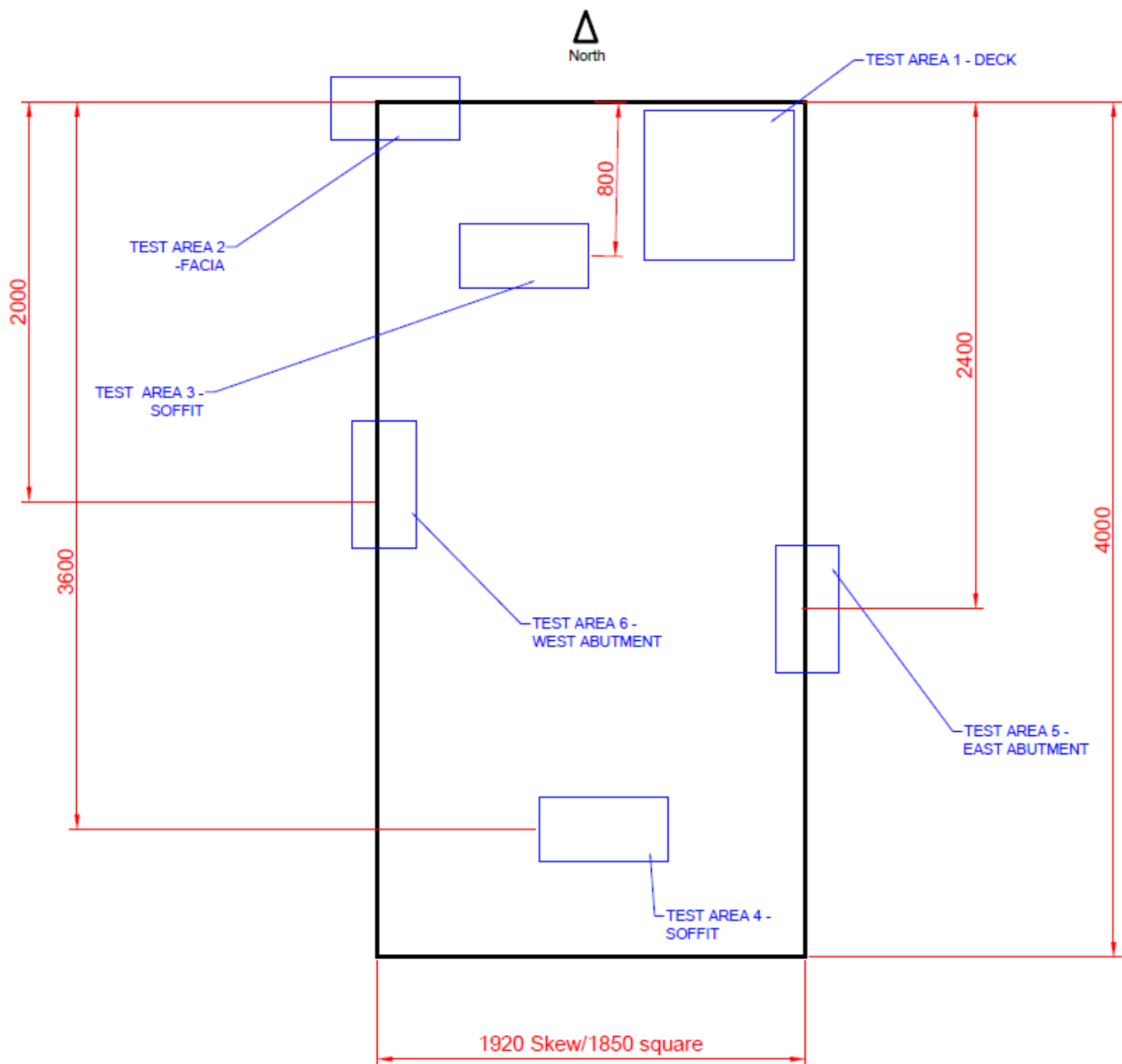
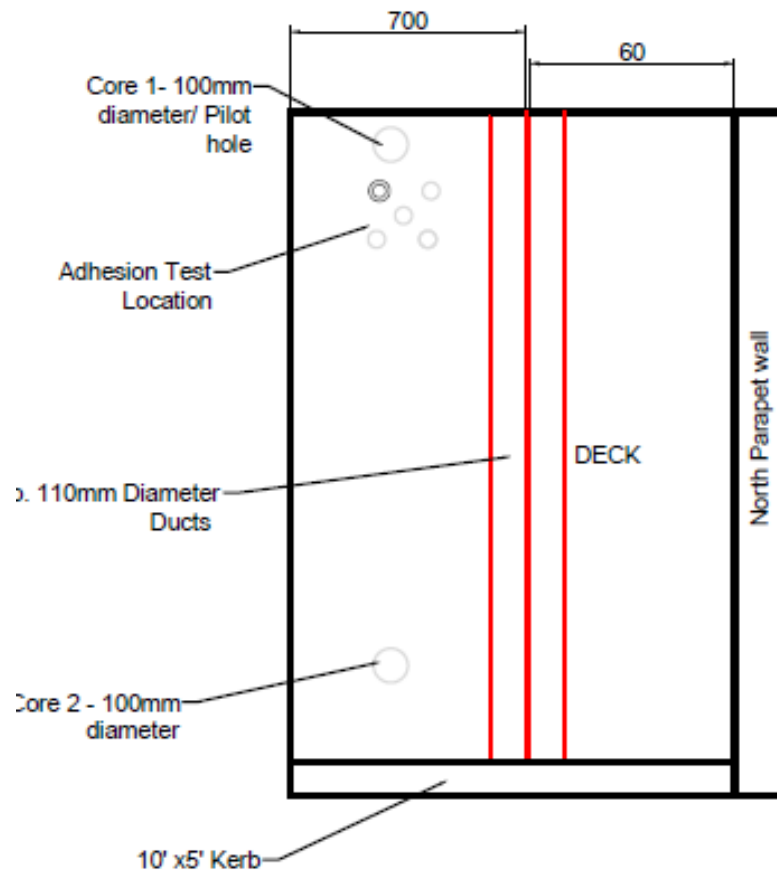


Figure 1: Carrowrevagh test area plan

TRIAL PIT 01/ TA1
-Plan



TRIAL PIT 01/ TA1
-Side section

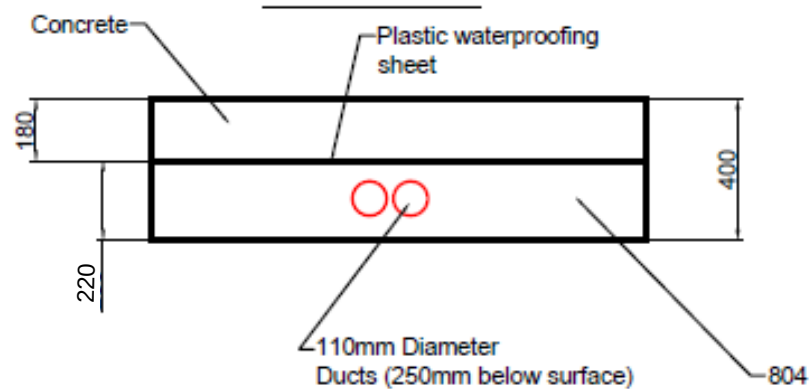
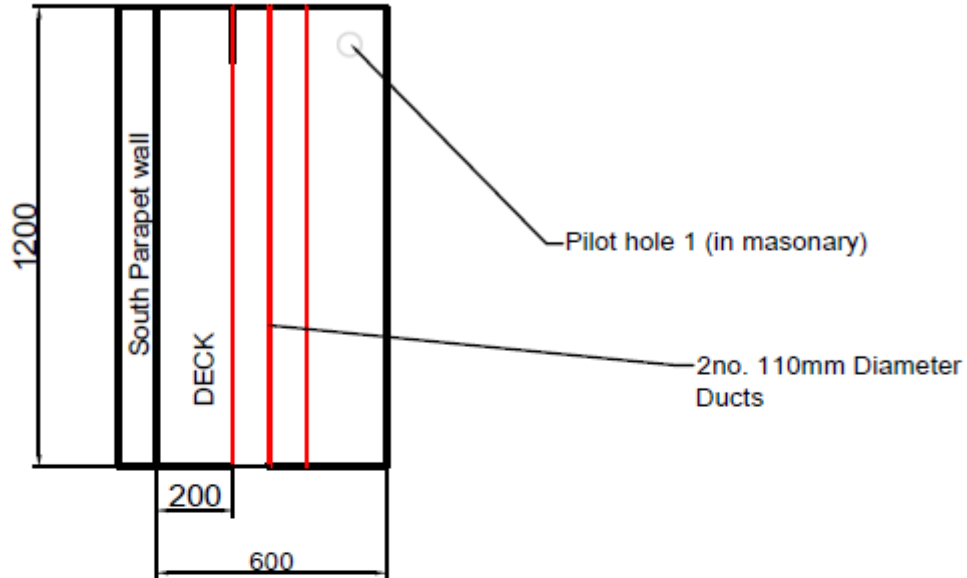


Figure 2: Trial pit 1

**TRIAL PIT 02/
Stone arch - Plan**



**TRIAL PIT 02/ stone
arch - Side section**

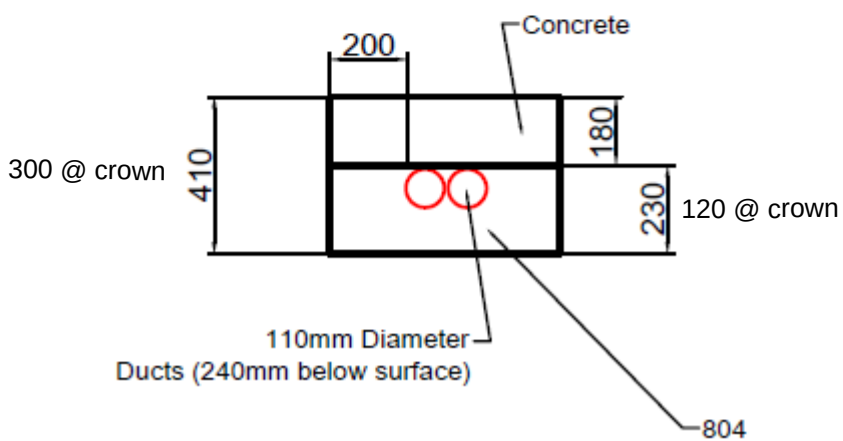


Figure 3: Trial pit 2

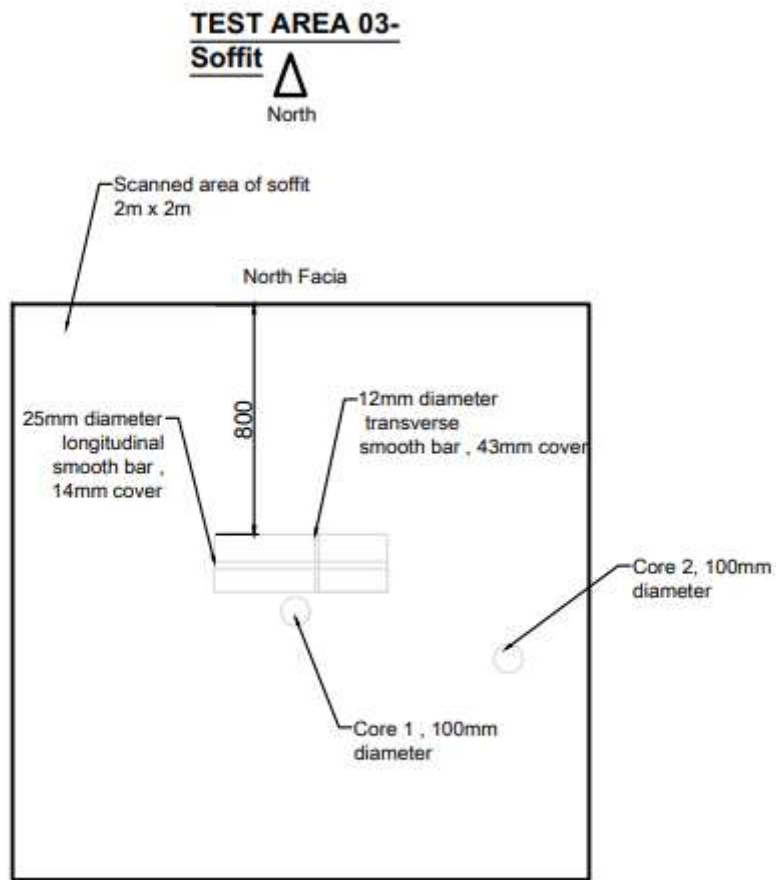


Figure 4: Test area 3 - Soffit

TEST AREA 04 -
Soffit

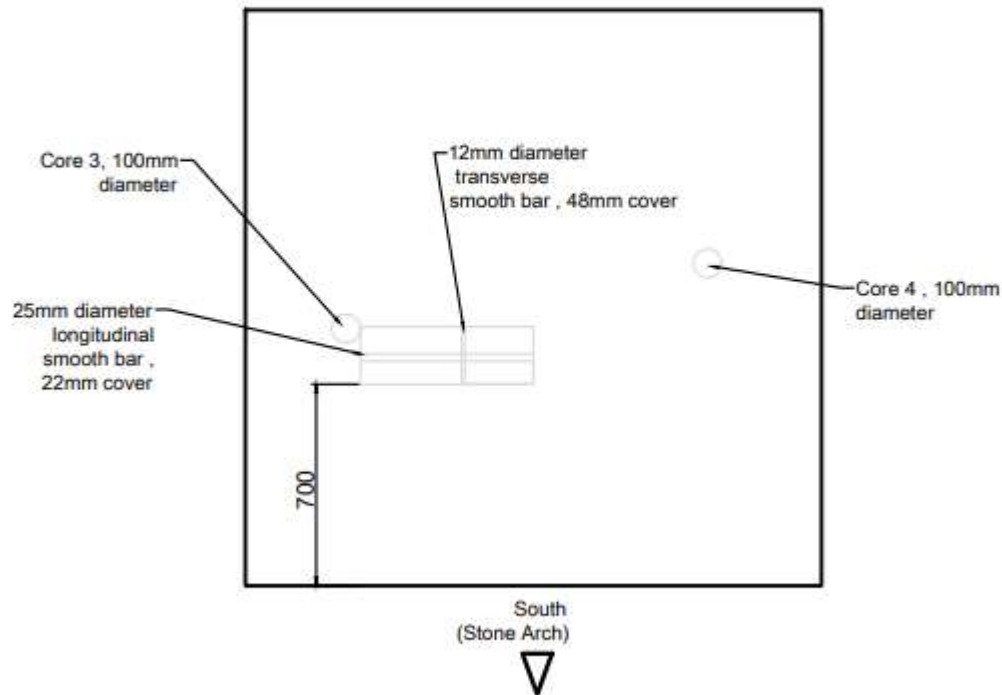


Figure 5: Test Area 4 - Soffit

**Stone Arch - Side
Elevation**

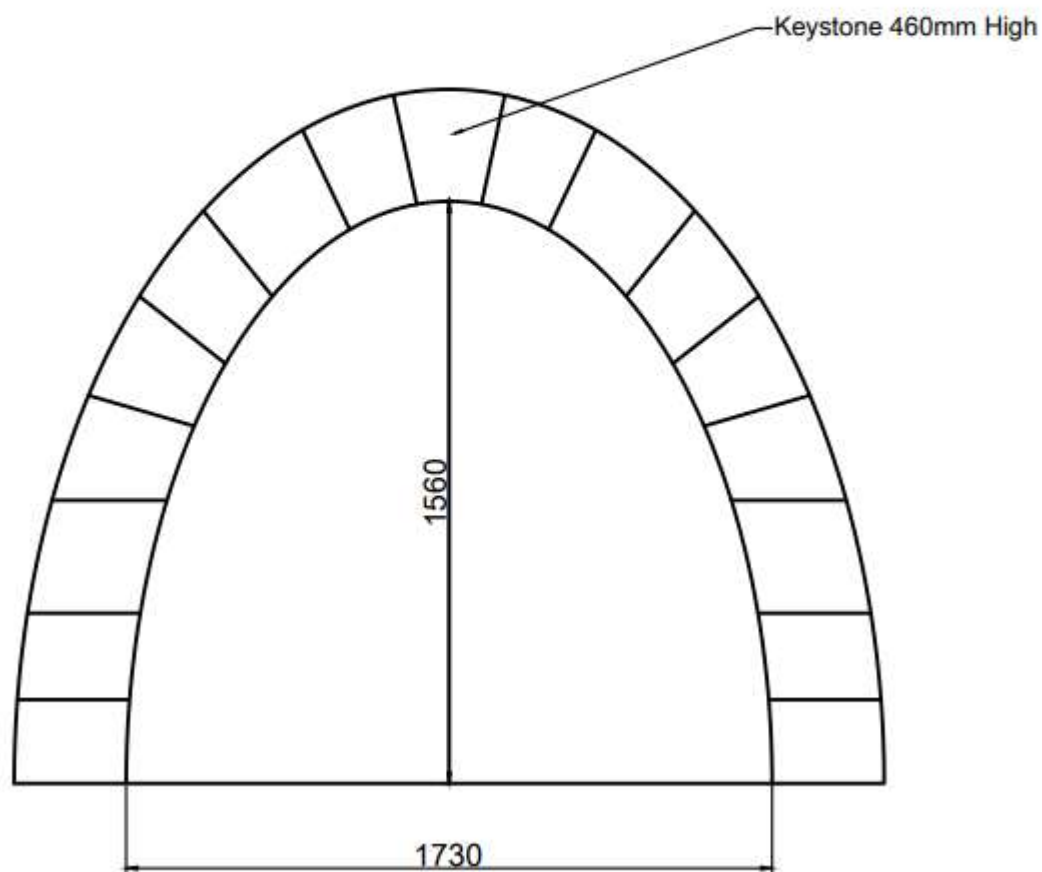


Figure 6: Stone arch details

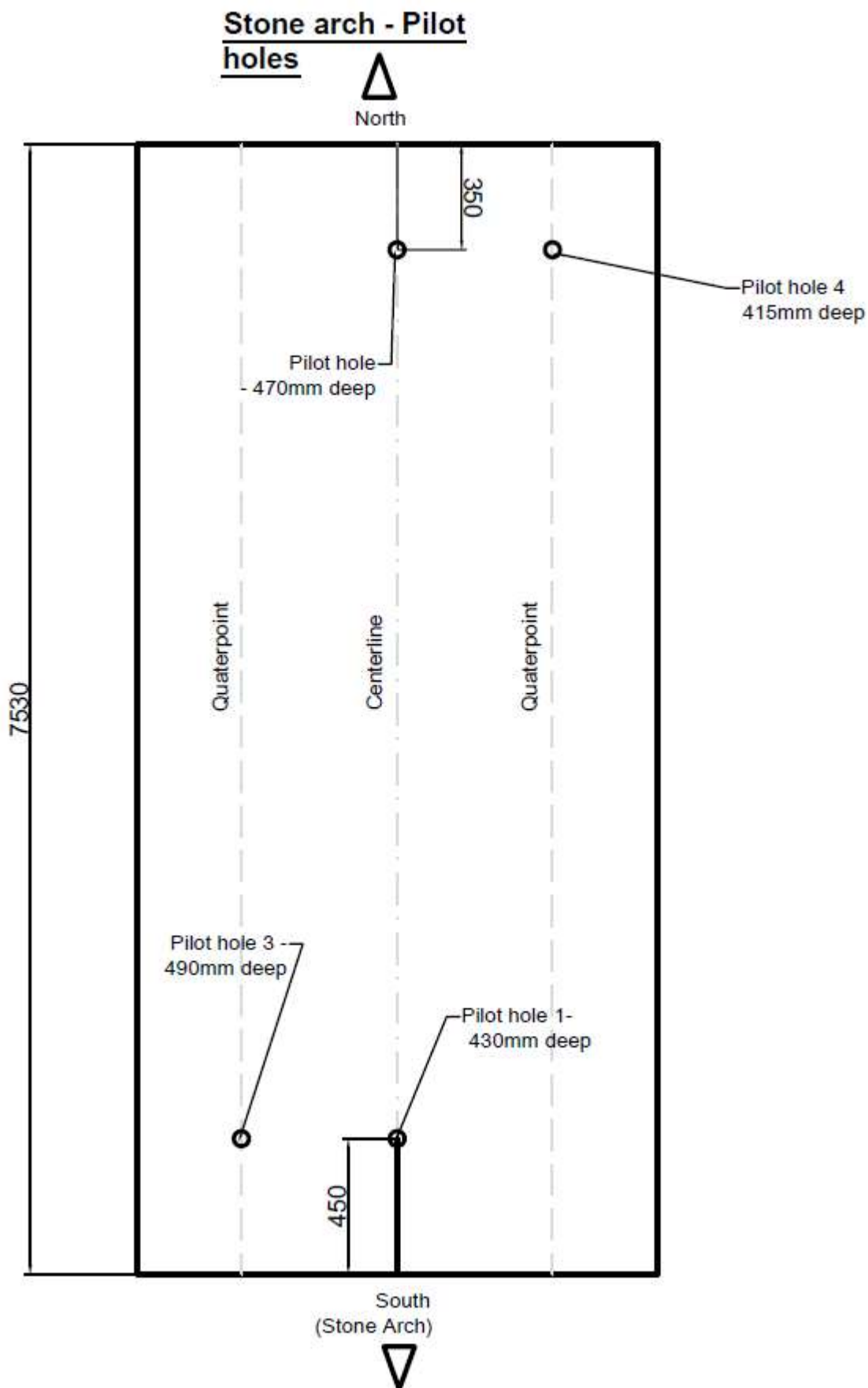


Figure 7: Pilot hole locations in masonry arch bridge

6. Reinstatement Works

- Rubbing strip cutouts were backfilled with UGM A and infilled with 35N 10mm agg



- Fosroc Renderoc HB45 was used to carry out concrete repairs to breakouts.



- Masonry Repairs were carried out with NHL5 Lime based mortar with a mix design of 2:1



7. PHOTO REPORT

TEST AREA 1



Figure 8: Deck scan of reinforcement(located on soffit side)



Figure 9: TA1 Cores 1,2 and adhesion test in place



Figure 10: C1 /PH1 core hole depth measurement



Figure 11: Extracted core samples C1 and C2



Figure 12: Adhesion test readings

TP2



Figure 13: Ducts exposed above arch



Figure 14: Fill layers above arch



Figure 15: Pilot hole drilled through masonry in-line with keystone

Test Area 2



Figure 16: Test area 2 - Scanned area



Figure 17: Test area 2 breakout



Figure 18: No reinforcement found in the breakout



Figure 19: TA2 reinstatement

Test Area 3



Figure 20: TA3 scanned area (Reinforcement marked with white chalk)



Figure 21: Longitudinal and Transverse Reinforcement



Figure 22 : Breakout area with core holes C1,C2 to the right



Figure 23: Close up of exposed reinforcement



Figure 24: Measurement of cover



Figure 25:TA3 and TA4 reinstatement

Test Area 4



Figure 26: TA4 breakout area



Figure 27 : Exposed Longitudinal and Transverse Reinforcement



Figure 28: Transverse and Longitudinal smooth bar



Figure 29: Measurement of bar sizing



Figure 30: Core sample C3



Figure 31: Cover measurement of reinforcement

Test Area 5



Figure 32: TA5 scanned area



Figure 33: pilot hole core material



Figure 34: Pilot hole depth measurement

Test Area 6



Figure 35: Scanned area



Figure 36: Extraction of durability testing samples



Figure 37: Pilot hole core material



Figure 38: Pilot hole depth measurement

Masonry Arch Pilot holes



Figure 39: Keystone Measurement



Figure 40: South facia



Figure 41: Pilot hole drilled through joint



Figure 42: PH2



Figure 43: Measurement of pilot hole depth

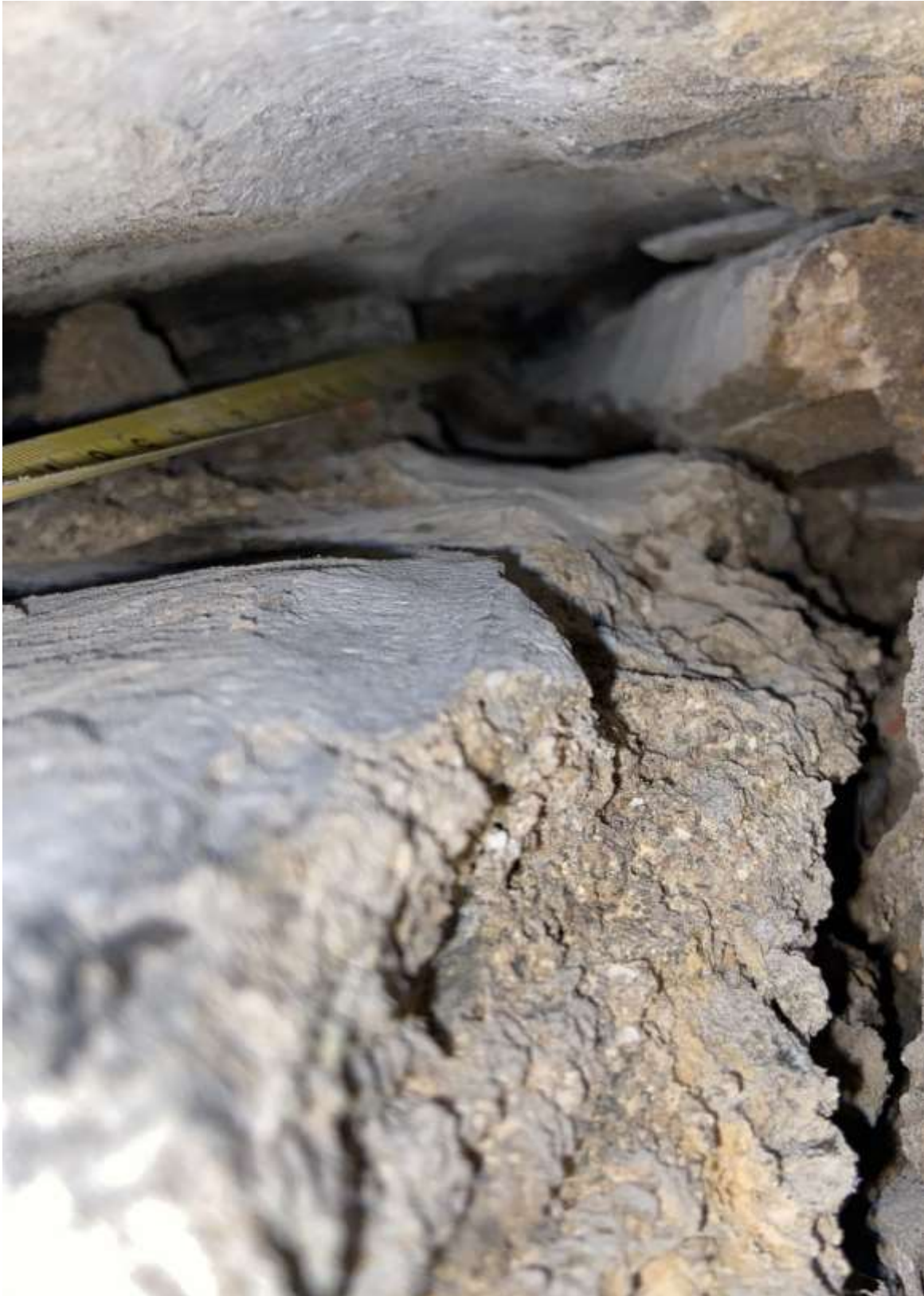


Figure 44: Pilot hole drilled between loose masonry



Figure 45: PH3

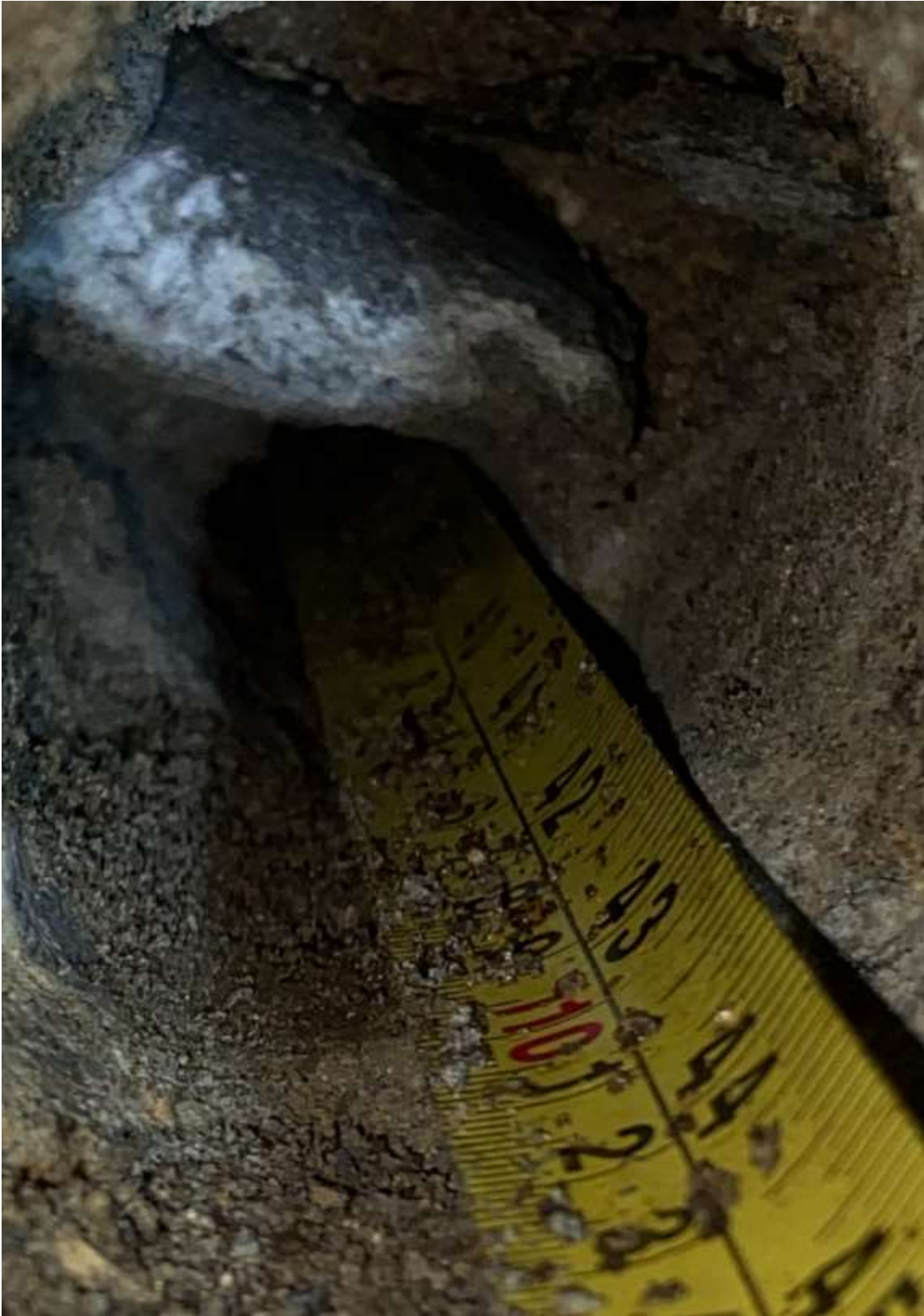


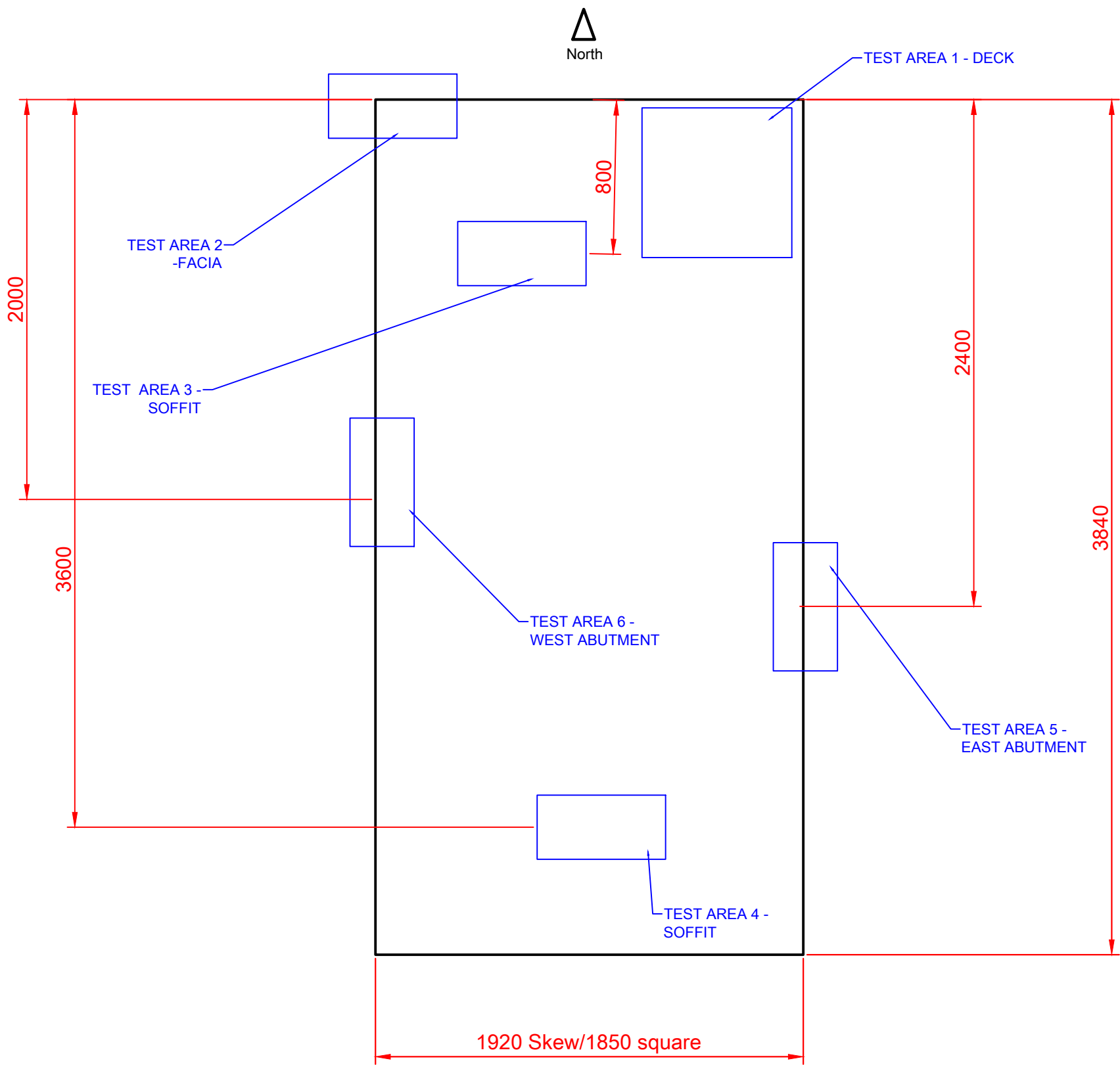
Figure 46: Measurement of pilot hole depth



Figure 47: PH4

Appendix 1 – Layout Drawing

Carrowrevagh Bridge- PLAN



Appendix 2 – Lab Test report

Mayo Bridges Inspection – Carrowrevagh Bridge

Concrete Testing Report

2024

Document Issue Register

Distribution	Report Status	Revision	Date of Issue	Prepared by	Approved by
Lurcan Donnellan Triur Construction	Final	A	4 th September 2024	Anton Hajek	James Purcell 

Contents

1.0	Project Overview	Page 4
2.0	Project Requirements	Page 4
3.0	Location of Works	Page 4
4.0	Summary of Results	Page 5 – 14

Compressive Strength Test Report	Appendix A
Pull Off Test Report	Appendix B
Carbonation Test Report	Appendix B
Reinforcement Test Report	Appendix C
Chloride Ion Test Report	Appendix D
Cement Content Test Report	Appendix E
Half Cell and Resistivity Test Report	Appendix F

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.

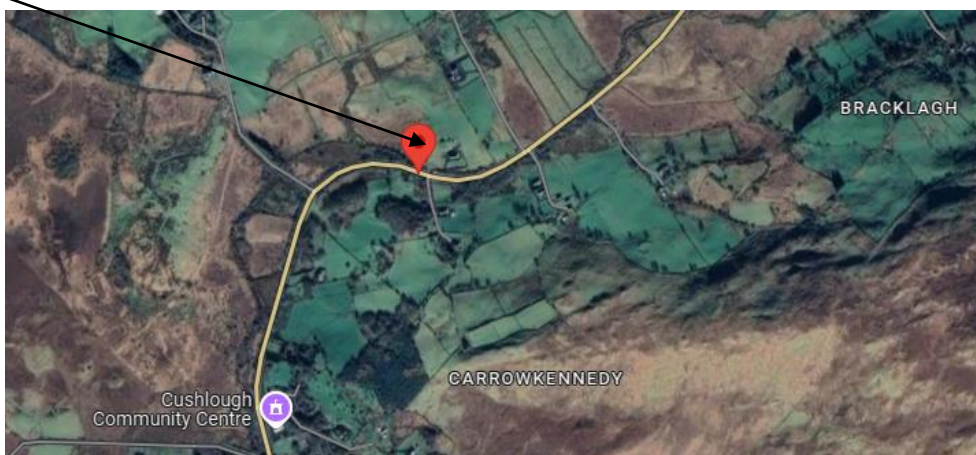
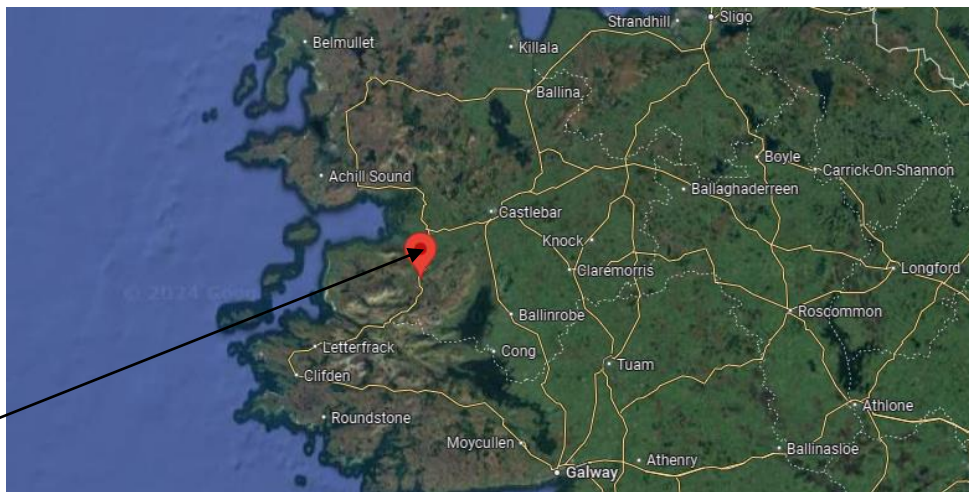
2.0 Project Requirements

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

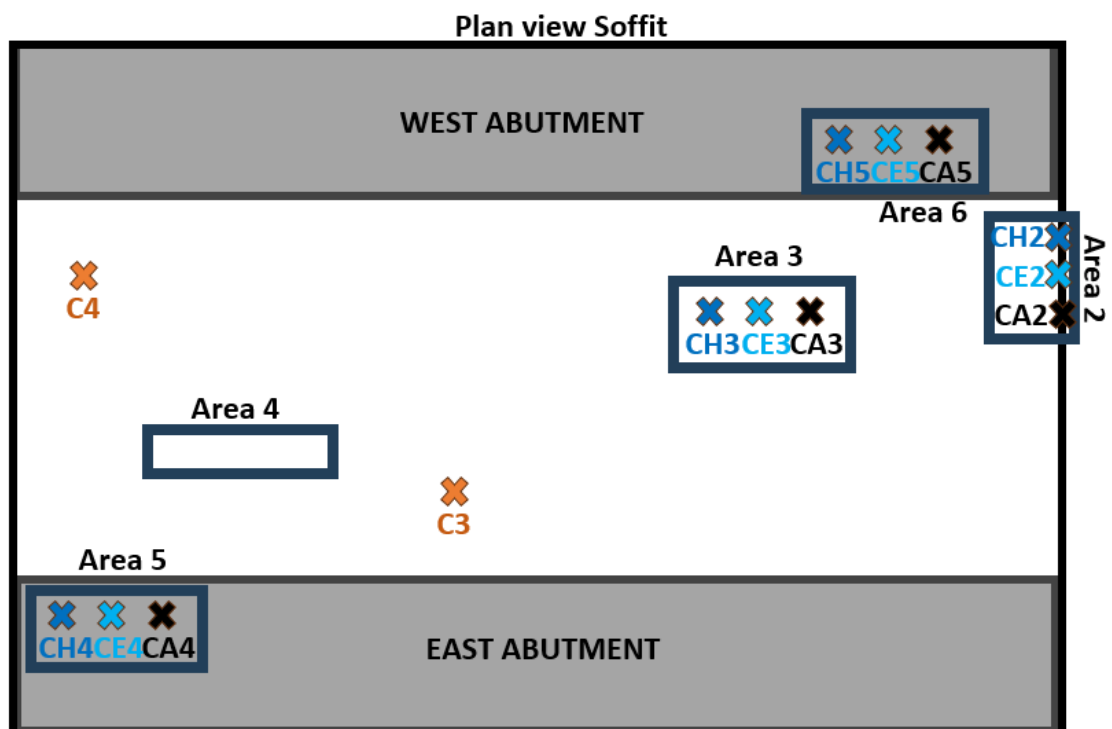
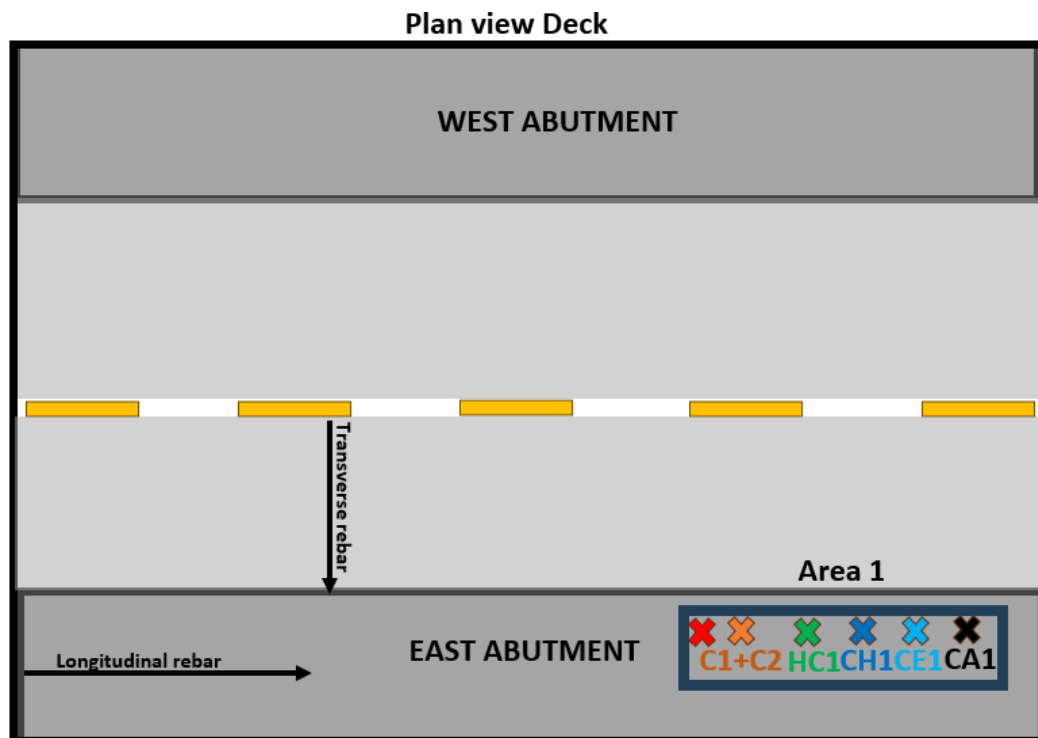
- Drill 4No. 100 diameter cores.
- Test for Density, Compressive strength and Visual examination.
- Chemical testing includes chloride content, cement content and depth of carbonation.
- Pull off testing on the concrete deck.
- Reinforcement scanning of concrete deck and parapets.
- Half-cell potential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

3.0 Location of Works

Site Location /
Works Area



4.0 Summary of Results



- *Key**
- ✕ Cores
 - ✕ Half-cell
 - ✕ Pull test
 - ✕ Chloride
 - ✕ Carbonation
 - ✕ Cement

4.1 Concrete Cores – Compressive Strength

In line with the project specification, BHP removed several 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:

BHP Ref:	Core Ref.	Details	Density kg/m ³	Compressive Strength N/mm ²
24/07/206-1	Core 1 – Top deck	25mm Gravel 1.5% Voids	2300	61.1
24/07/206-2	Core 2 – Top deck	35mm Gravel 1% Voids	2260	56.6
24/07/206-3	Core 3 – Soffit	30mm Gravel 1.5% Voids	2320	68.1
24/07/206-4	Core 4 – Soffit	30mm Gravel 1% Voids	2330	56.2

The mean result for compressive strength for top deck cores is 59N/mm² with a standard deviation of 3.18. The mean density of the test specimens is 2280kg/m³.

The mean result for compressive strength for soffit cores is 62.1N/mm² with a standard deviation of 8.41. The mean density of the test specimens is 2325kg/m³.

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	3.2	0	Below adhesive on top of concrete surface (adhesion failure)
Area 1 top deck	4.3	0	Below adhesive on top of concrete surface (adhesion failure)
Area 1 top deck	8.4	0	Below adhesive on top of concrete surface (adhesion failure)
Area 1 top deck	10	0	Below adhesive on top of concrete surface (adhesion failure)
Area 1 top deck	2.0	0	Below adhesive on top of concrete surface (adhesion failure)
Mean	5.58		

4.3 Carbonation

In accordance with the project specification, the carbonation testing was to be performed at seven 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 Carrowrevagh Bridge, Co. Mayo are contained in Appendix C of this report.

A summary of the results is contained below:

Location	Depth of Carbonation (mm)
Carbonation Test 1 – C1 Top deck	12
Carbonation Test 2 – C3 Soffit	<1
Carbonation Test 3 – Area 2 Face Deck	<1
Carbonation Test 4 – Area 5 East Abutment	2
Carbonation Test 5 – Area 6 West Abutment	10

4.4 Reinforcement Details

In following page, 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 Carrowrevagh Bridge, Co. Mayo.

Full details are in Appendix D of this report.

Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing	Minimum Spacing (mm)	Maximum Spacing (mm)
Area 1 Top deck Longitudinal rebar	214	203	223	217	200	240
Area 1 Top deck transverse rebar	N/A	N/A	N/A	N/A	N/A	N/A
Area 2 Face deck vertical rebar	93	N/A	N/A	N/A	N/A	N/A
Area 2 Face deck horizontal rebar	183	181	187	585	570	600
Area 3 Soffit Longitudinal rebar	20	17	24	160	140	180
Area 3 Soffit Transverse rebar	52	48	56	196	180	220
Area 4 Soffit Longitudinal rebar	25	20	31	151	140	180
Area 4 Soffit Transverse rebar	48	43	56	207	190	240
Area 5 East Abutment vertical scan	N/A	N/A	N/A	N/A	N/A	N/A
Area 5 East Abutment horizontal scan	N/A	N/A	N/A	N/A	N/A	N/A
Area 6 West Abutment vertical scan	N/A	N/A	N/A	N/A	N/A	N/A
Area 6 West Abutment horizontal scan	N/A	N/A	N/A	N/A	N/A	N/A

Reinforcement found by completing a breakout	Actual cover (mm)	Diameter (mm)
Area 3 Soffit longitudinal smooth rebar	14	25.16
Area 3 Soffit longitudinal smooth rebar	43	13.84
Area 4 Soffit longitudinal smooth rebar	22	25.26
Area 4 Soffit longitudinal smooth rebar	48	12.55

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 Carrowrevagh 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 five locations, the chloride content as a percentage of cement is below this value.

A summary table of the results is found below:

Location Reference	Sample Reference	Depth (mm)	Chloride Content % by mass of	
			Sample	Cement
Area 1	24/07/206-8-11	5-30mm	<0.01	<0.02
		30-55mm	<0.01	<0.02
		55-80mm	<0.01	<0.02
		80-105mm	<0.01	<0.02
Area 2	24/07/206-13-16	5-30mm	0.01	0.08
		30-55mm	0.01	0.08
		55-80mm	0.01	0.08
		80-105mm	0.01	0.08
Area 3	24/07/206-18-21	5-30mm	0.01	0.06
		30-55mm	<0.01	<0.02
		55-80mm	<0.01	<0.02
		80-105mm	<0.01	<0.02
Area 5	24/07/206-23-26	5-30mm	<0.01	<0.02
		30-55mm	0.01	0.08
		55-80mm	<0.01	<0.02
		80-105mm	<0.01	<0.02
Area 6	24/07/206-28-31	5-30mm	0.01	0.08
		30-55mm	0.01	0.08
		55-80mm	0.01	0.08
		80-105mm	0.01	0.08

4.5 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 Carrowrevagh bridge, Co. Mayo was undertaken on three samples. The samples came from deck, abutments and soffits in different levels. The mean cement content results for the three samples is 15% with a range of 12% – 19%. A summary table of the results is found below.

Location	Cement Content (%)	Compressive Strength (N/mm2) – from core test
Area 1	19	61.1,56.6
Area 2	13	-
Area 3	18	68.1,56.2
Area 5	12	-
Area 6	13	-

A cement content of 16-17% would normally indicate an approximate in-situ compressive strength of 50N.

Check for conformity

Mean strength	61	
Lowest strength	56.2	
Characteristic strength	50	
M – Table 8 of EN 13791	4	
Compliance	Mean $\geq 0.85 \times (50+1)$	61 > 43.35
	Lowest $\geq 0.85 \times (50-4)$	56.2 > 39.1

4.6 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 this 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 steel corrosion activity
>-200	Less than 10%
-200 to -350	Uncertain
<-350	More than 90%

Half Cell Potential Results

Location	Mean (mV)	Lowest (mV)	Highest (mV)	Standard Deviation (mV)
Area 3 Soffit	-134.1	-179	-91	23.7

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%. Based on the results and visual examination of the bars on site when broken out, the likelihood of corrosion based on half-cell results is in the initial phase.

In addition to half-cell potential surveying of concrete, resistivity measurements of the same concrete material provide further information on the potential for further corrosion taking or to take place. Corrosion of reinforcing steel is an electro-chemical process. For corrosion of the steel to occur a current must pass between the anodic and cathodic regions of the concrete. The electrical resistivity of the concrete affects the flow of ions and the rate at which corrosion can occur. A higher concrete resistivity decreases the flow; an empirical relationship between corrosion rate and resistivity has been determined from measurements on actual structures.

Electrical resistivity measurement techniques are becoming popular among consulting / design engineers for the quality assessment and durability assessment of concrete. The concept of durability of concrete depends largely on the properties of its microstructure, such as pore size distribution and the shape of the interconnections (that is, tortuosity). A finer pore network, with less connectivity, leads to lower permeability. A porous microstructure with larger degree of interconnections, on the other hand, results in higher permeability and reduced durability in general. The principal idea behind most electrical resistivity techniques is to somehow quantify the conductive properties of the microstructure of concrete. Overall, the electrical resistivity of concrete can be described as the ability of concrete to withstand the transfer of ions subjected to an electrical field. In this context, resistivity measurement can be used to assess the size and extent of the interconnectivity of pores.

Various approaches for measuring resistivity are available but the four-probe device is the most suitable. Modern devices are spring-loaded and are applied directly to the surface. A current is applied between the two outer probes and the potential difference measured between the two inner probes. Resistivity measurement is useful for identifying areas of reinforced concrete at risk from corrosion. It should not be considered in isolation but used in conjunction with other techniques such as half-cell potential. BHP employed the use of the latest version of Proceq's Resipod with 50mm spacings between the four probes.

From the testing undertaken at this structure, we found that there was a negligible risk of corrosion based on the resistivity results.

Location	Result 1	Result 2	Result 3	Result 4	Result 5
Area 3 Soffit	172	176	273	271	235
Area 3 Soffit	270	280	245	242	256

Appendix A



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.: 24/07/206-1
Order No: Not Supplied
Date Tested: 08/08/2024
Test Specification: Customer Spec.
Test Element: Concrete Core

Project: Mayo Bridges Investigation - Carrowrevagh Bridge
Location Reference: C1 Top deck
Test Standard: EN 12504-1:2019

Core Details			
Coring Date	29/07/2024	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	1.5%	Ribbing on core surface	None
Honeycombing	None	Flatness	Pass
Presence of cracks	None	Perpendicularity	Pass
Type of aggregate	Gravel	Straightness	Pass
Test Information			
Preparation		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	290
		Minimum length of specimen, as received	290
		Density of the specimen, as received (kg/m ³)	2300
		Max Load (KN)	470.8
		Compressive Strength (N/mm ²)	61.1

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.

Approved By:	Signature:
Lukasz Zalewski Field Service Manager	

For and On Behalf of BHP Laboratories

Issue Date: 04/09/2024

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.: 24/07/206-2
Order No: Not Supplied
Date Tested: 08/08/2024
Test Specification: Customer Spec.
Test Element: Concrete Core

Project: Mayo Bridges Investigation - Carrowrevagh Bridge
Location Reference: C2 Top deck
Test Standard: EN 12504-1:2019

Core Details			
Coring Date	29/07/2024	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)	35
Compaction of concrete	Good	Distribution of materials	Even
Excess Voids	1.0%	Ribbing on core surface	None
Honeycombing	None	Flatness	Pass
Presence of cracks	None	Perpendicularity	Pass
Type of aggregate	Gravel	Straightness	Pass
Test Information			
Preparation		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	290
		Minimum length of specimen, as received	290
		Density of the specimen, as received (kg/m ³)	2260
		Max Load (KN)	434.0
		Compressive Strength (N/mm ²)	56.6

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.

Approved By:	Signature:
Lukasz Zalewski Field Service Manager	

For and On Behalf of BHP Laboratories

Issue Date: 04/09/2024

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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.: 24/07/206-3
Order No: Not Supplied
Date Tested: 08/08/2024
Test Specification: Customer Spec.
Test Element: Concrete Core

Project: Mayo Bridges Investigation - Carrowrevagh Bridge
Location Reference: C3 Soffit
Test Standard: EN 12504-1:2019

Core Details			
Coring Date	29/07/2024	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)	30
Compaction of concrete	Good	Distribution of materials	Even
Excess Voids	1.5%	Ribbing on core surface	None
Honeycombing	None	Flatness	Pass
Presence of cracks	None	Perpendicularity	Pass
Type of aggregate	Gravel	Straightness	Pass
Test Information			
Preparation		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	245
		Minimum length of specimen, as received	245
		Density of the specimen, as received (kg/m³)	2320
		Max Load (KN)	522.9
		Compressive Strength (N/mm²)	68.1

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.

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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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.: 24/07/206-4
Order No: Not Supplied
Date Tested: 08/08/2024
Test Specification: Customer Spec.
Test Element: Concrete Core

Project: Mayo Bridges Investigation - Carrowrevagh Bridge
Location Reference: C4 Soffit
Test Standard: EN 12504-1:2019

Core Details			
Coring Date	29/07/2024	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)	30
Compaction of concrete	Good	Distribution of materials	Even
Excess Voids	2.5%	Ribbing on core surface	None
Honeycombing	None	Flatness	Pass
Presence of cracks	None	Perpendicularity	Pass
Type of aggregate	Gravel	Straightness	Pass
Test Information			
Preparation		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	150
		Minimum length of specimen, as received	150
		Density of the specimen, as received (kg/m³)	2330
		Max Load (KN)	431.8
		Compressive Strength (N/mm²)	56.2

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.

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 B

BOND STRENGTH BY PULL OFF TEST REPORT



BHP/MTIField/F045 V1 15/04/24

Client: TRIUR Construction Ltd
13 Society Street
Ballinasloe
Galway
FAO: Lurcan Donnellan
Project: Mayo Bridges - Carrowrevagh Bridge
Location Reference: See below
Test Standard: BS EN 1542

BHP Ref. No.: 24/07/206
Order No: Not Supplied
Date Tested: 30/07/2024
Test Specification: Customer Spec.
Test Element: Concrete Surface

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 Deck	3.2	0.0	Below adhesive on top of substrate
Area 1 Deck	4.3	0.0	Below adhesive on top of substrate
Area 1 Deck	8.4	0.0	Below adhesive on top of substrate
Area 1 Deck	10.0	0.0	Below adhesive on top of substrate
Area 1 Deck	2.0	0.0	Below adhesive on top of substrate
Mean	5.58		

REMARKS:

Elcometer 506 Pull - Off Adhesion Tester

Approved By:	Signature:
Lukasz Zalewski Field Service Manager	

For and On Behalf of BHP Laboratories

Issue Date: 04/09/2024

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

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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

BHP Ref. No.: 24/07/206
Order No: Not Supplied
Date Tested: 07/08/2024
Test Specification: Customer Spec.
Test Element: Concrete Core

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

Location Reference	Carbonation (mm)	Notes
C1 Top deck	12	
C3 Soffit	<1.0	
Area 2 Face Deck	<1.0	
Area 5 East Abutment	2	
Area 6 West Abutment	10	

REMARKS:

Nil

Approved By:	Signature:
Lukasz Zalewski Field Service Manager	

For and On Behalf of BHP Laboratories

Issue Date: 04/09/2024

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

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Appendix D

TEST REPORT

Analysing
Testing
Consulting
Calibrating



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

BHP Ref No.: 24/07/206
Order No.: Not Supplied
Date Received: Not Applicable
Date Tested: 29/07/2024
Specification: Client Specification

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

Customer: Mr. Lurcan Donnellan.

Customer Reference: Reinforcement Scanning at Carrowevagh Bridge, Co. Mayo

Steel Reinforcement Survey

On Monday 29 July 2024, BHP Laboratories visited Carrowevagh 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 undertook scans of the top deck, face deck and soffit to ascertain the reinforcement position and cover. BHP conducted this reinforcement scanning using the latest technology from Proceq – Ground Penetration Radar (GPR)

Site Location



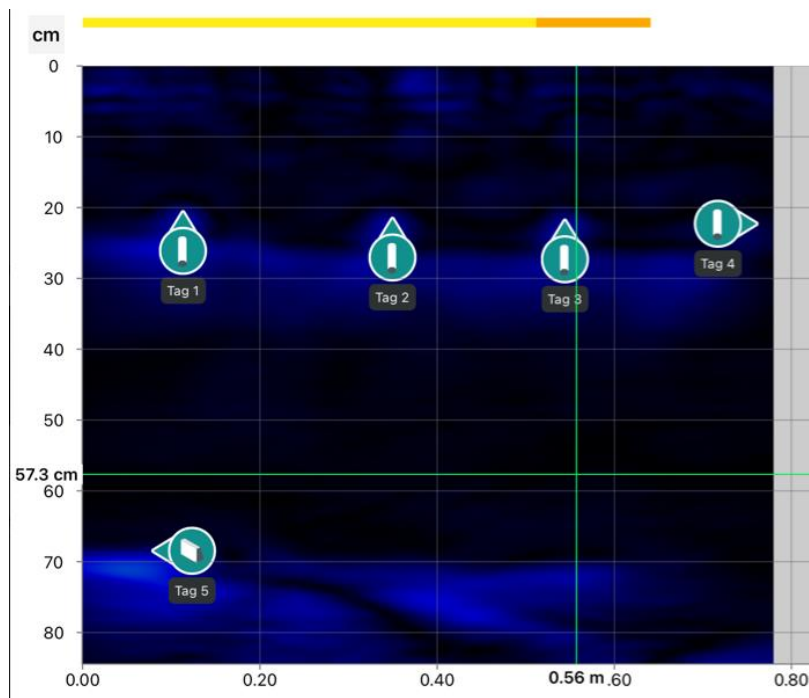
The scanning of the top deck, face deck and soffit bridge has found the following information / key points:

Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing	Minimum Spacing (mm)	Maximum Spacing (mm)
Area 1 Top deck Longitudinal rebar	214	203	223	217	200	240
Area 1 Top deck Transverse rebar	N/A	N/A	N/A	N/A	N/A	N/A
Area 2 Face deck vertical rebar	93	N/A	N/A	N/A	N/A	N/A
Area 2 Face deck horizontal rebar	183	181	187	585	570	600
Area 3 Soffit Longitudinal rebar	20	17	24	160	140	180
Area 3 Soffit Transverse rebar	52	48	56	196	180	220
Area 4 Soffit Longitudinal rebar	25	20	31	151	140	180
Area 4 Soffit Transverse rebar	48	43	56	207	190	240
Area 5 East Abutment vertical scan	N/A	N/A	N/A	N/A	N/A	N/A
Area 5 East Abutment horizontal scan	N/A	N/A	N/A	N/A	N/A	N/A
Area 6 West Abutment vertical scan	N/A	N/A	N/A	N/A	N/A	N/A
Area 6 West Abutment horizontal scan	N/A	N/A	N/A	N/A	N/A	N/A

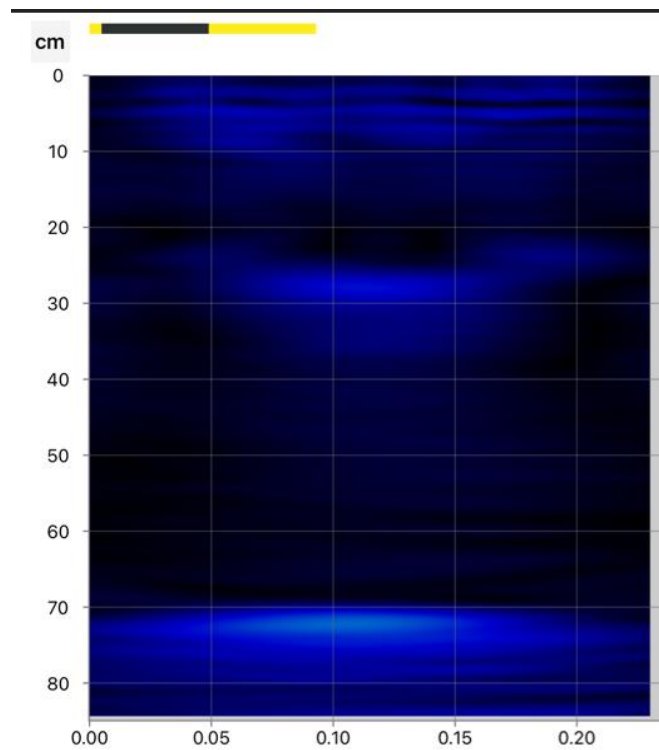
*From reinforcement scanning it's clear that in Abutment 5-6 GPR did not find any layout or rebars.

* In Area 1 Top deck there was not enough space to do a transverse scan.

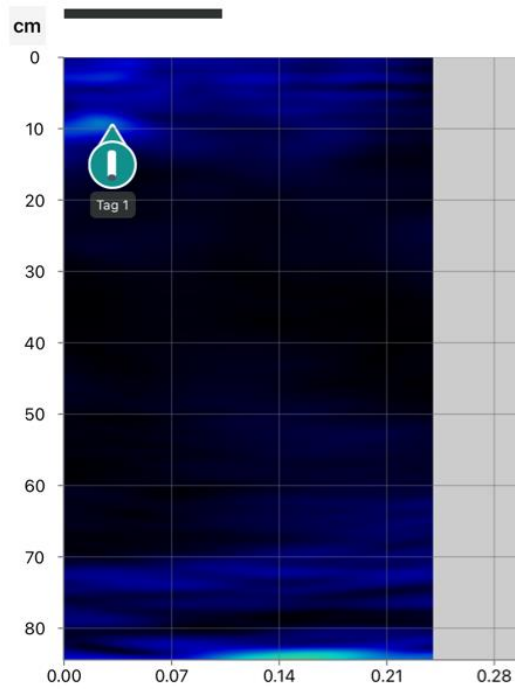
Reinforcement found by completing a breakout	Actual cover (mm)	Diameter (mm)
Area 3 Soffit longitudinal smooth rebar	14	25.16
Area 3 Soffit longitudinal smooth rebar	43	13.84
Area 4 Soffit longitudinal smooth rebar	22	25.26
Area 4 Soffit longitudinal smooth rebar	48	12.55



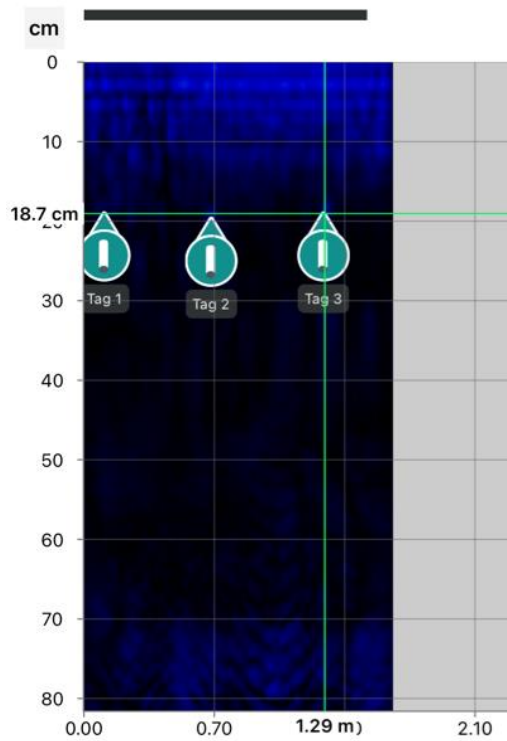
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 1 Top deck Longitudinal rebar 001	214	203	223	217



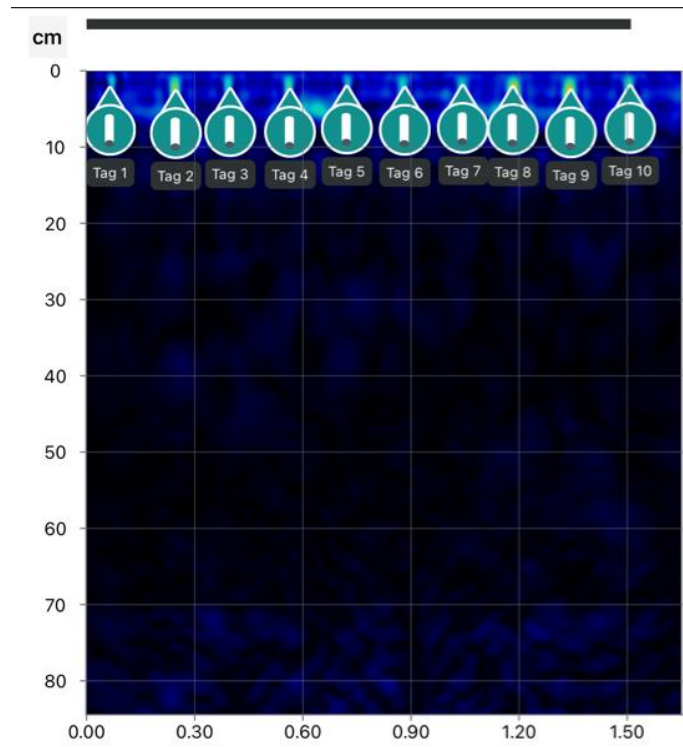
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 1 Top deck Transverse rebar 001	N/A	N/A	N/A	N/A



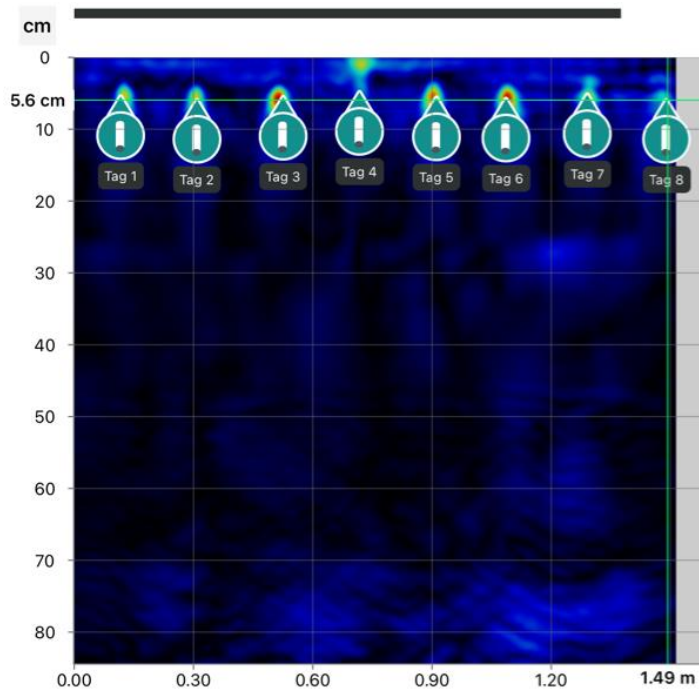
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 1 Top deck transverse rebar 001	93	N/A	N/A	N/A



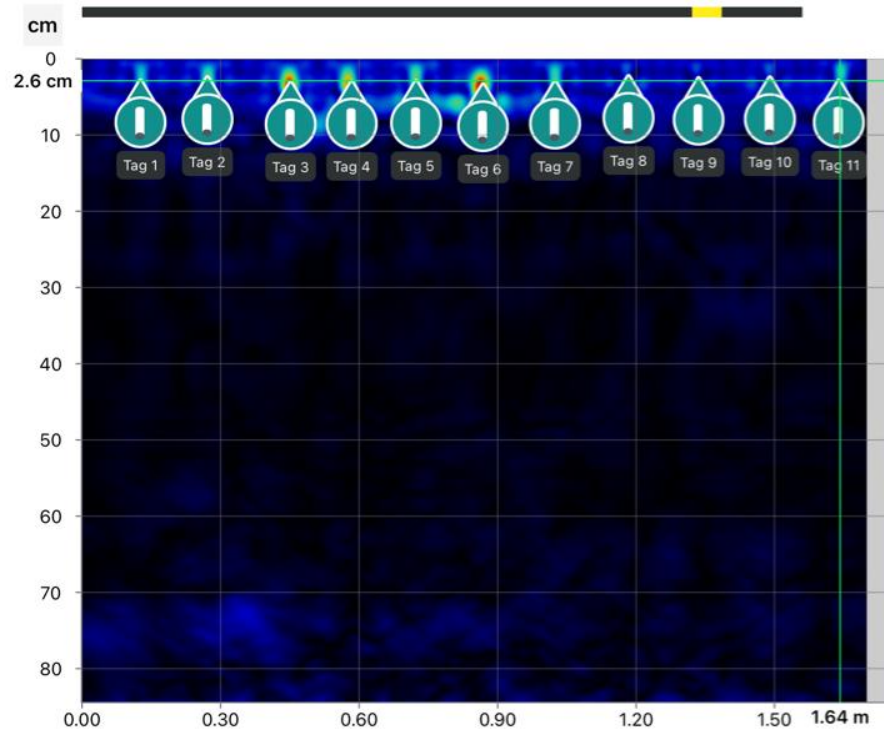
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 2 Face deck horizontal rebar	183	181	187	585



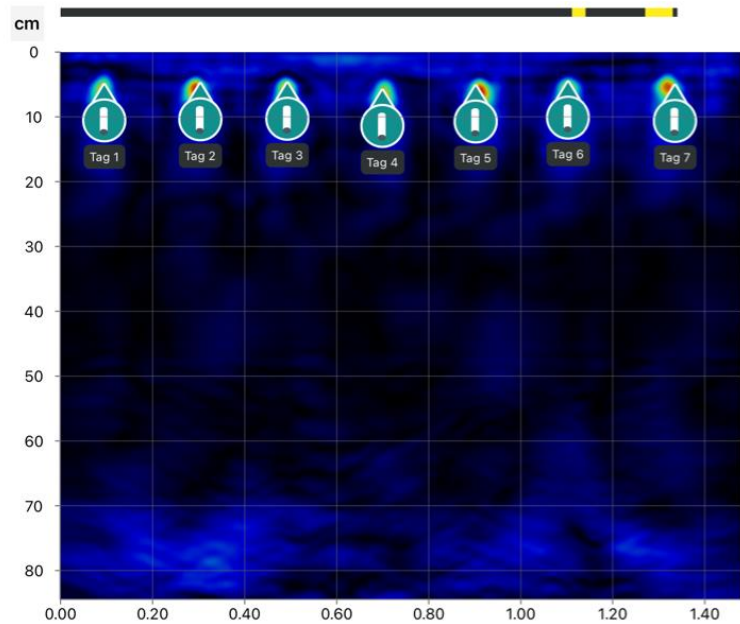
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 3 Soffit Longitudinal rebar	20	17	24	160



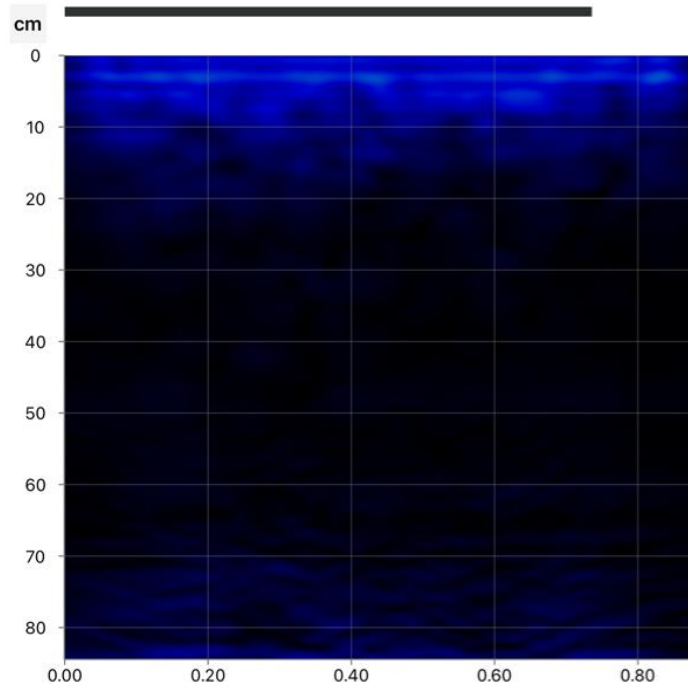
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 3 Soffit Transverse rebar	52	48	56	196



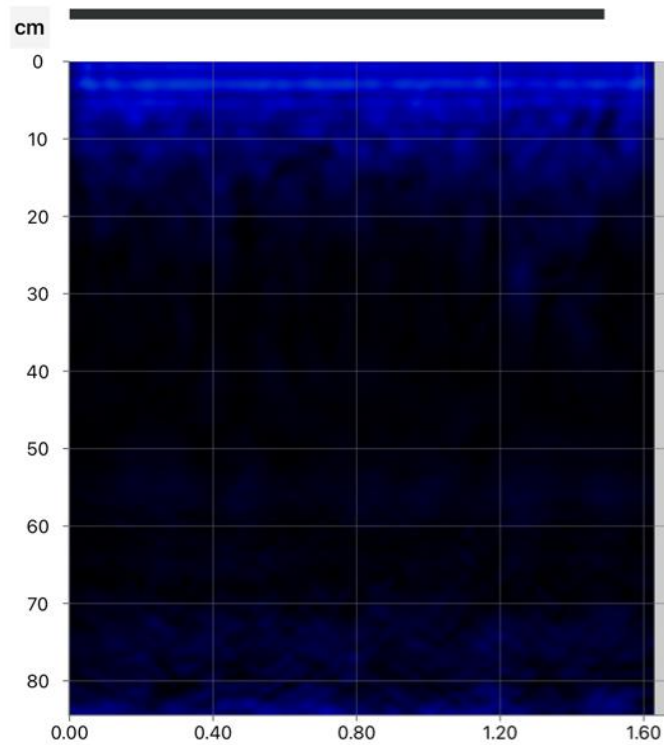
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 4 Soffit Longitudinal rebar 002	25	20	31	151



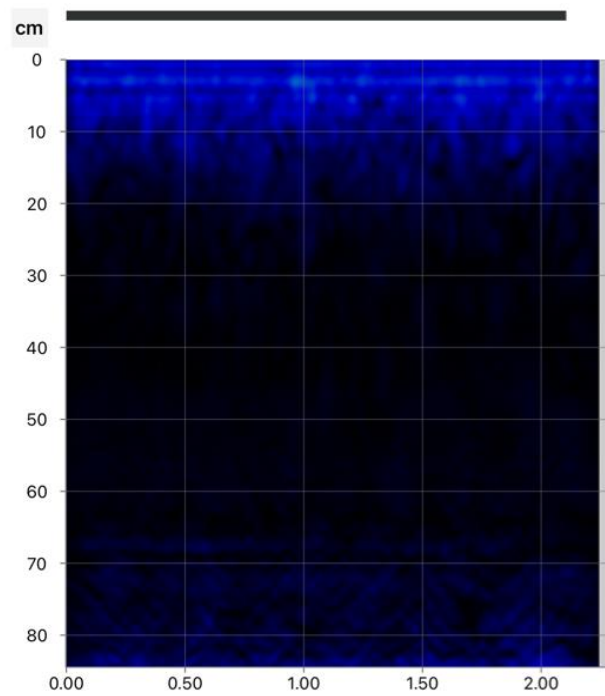
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 4 Soffit Transverse rebar	48	43	56	207



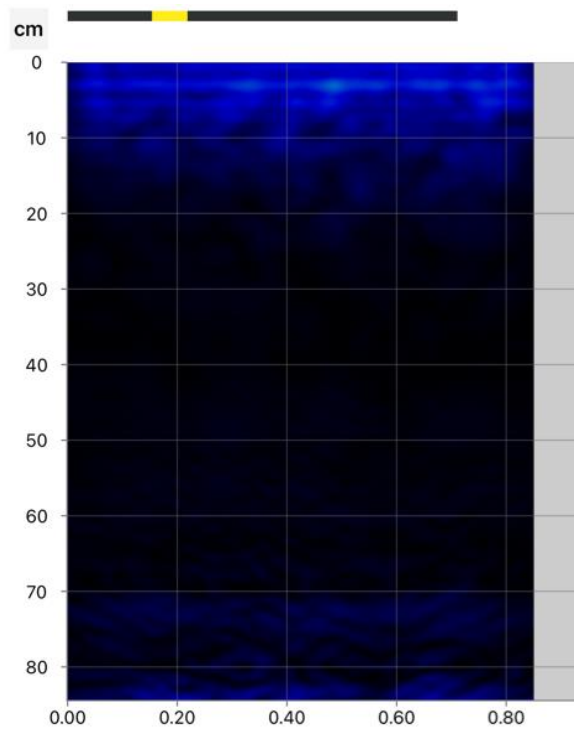
Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 5 East Abutment vertical scan	N/A	N/A	N/A	N/A



Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 5 East Abutment horizontal scan	N/A	N/A	N/A	N/A



Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 6 West Abutment vertical scan	N/A	N/A	N/A	N/A



Scan Location	Mean Cover (mm)	Lowest Cover (mm)	Highest Cover (mm)	Mean Spacing (mm)
Area 6 West Abutment horizontal scan	N/A	N/A	N/A	N/A

Authorised by:



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

Date Issued: 4th September 2024

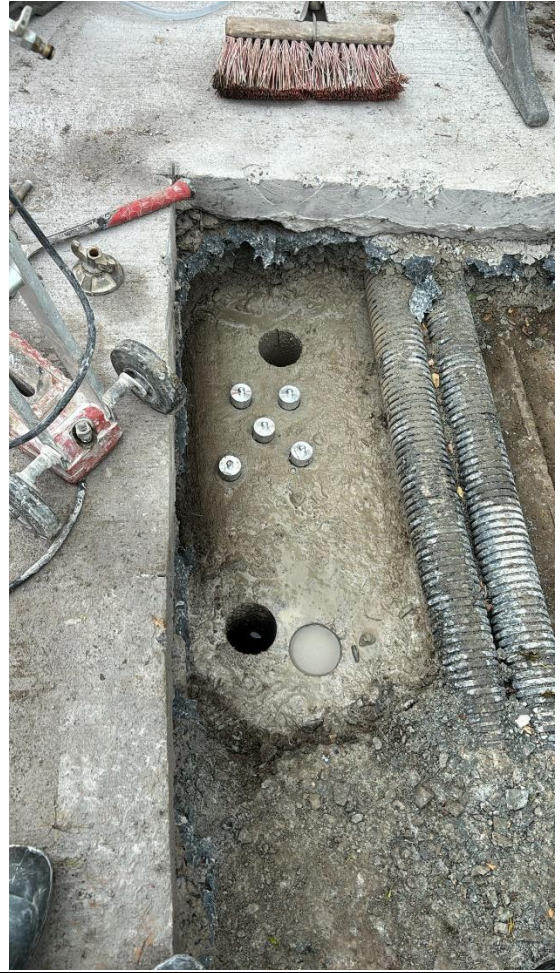
Test results relate only to this item. This test report shall not be duplicated except in full and with the permission of the test laboratory

Photographs of breakouts

Area 1 Top deck



Area 1 Top deck



Area 2 face deck



Area 3 soffit



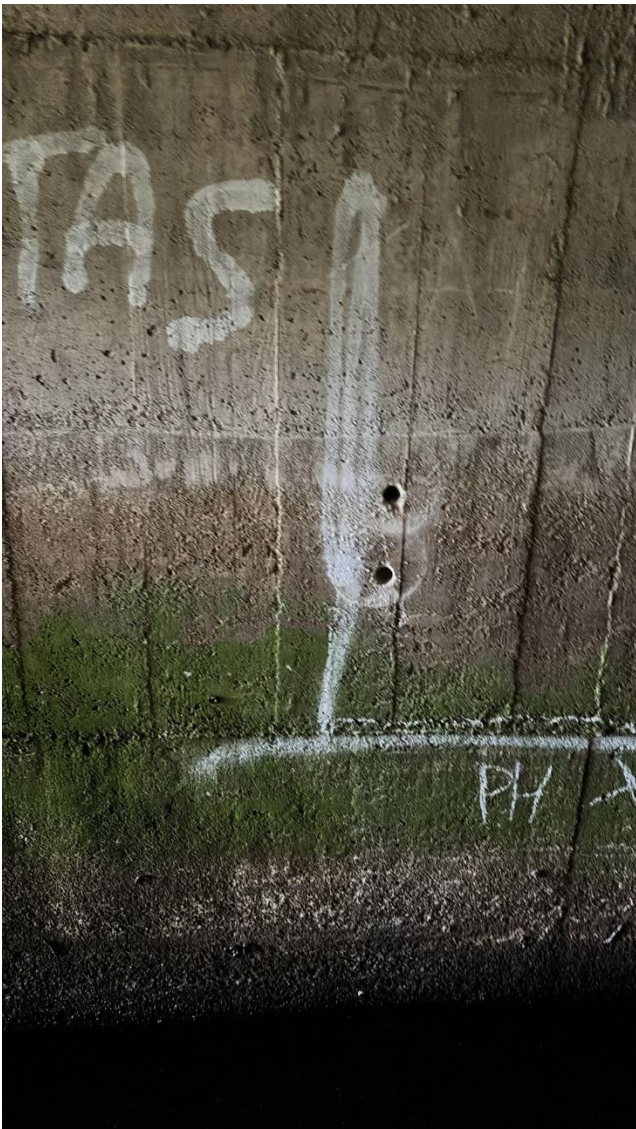
Area 3 Soffit



Area 4



Area 5 East Abutment



Area 6 West Abutment



Area 1 C1- 250mm



Area 1 C1- 240mm



Area 3 Soffit breakout



Area 3 Longitudinal smooth rebar 14mm cover



Area 3 transverse smooth rebar 43mm cover



Area 3 Longitudinal smooth rebar 25.16mm



16 - 12mm transverse



Area 4 Breakout



Area 4 smooth longitudinal rebar 22mm cover



Area 4 Transverse smooth rebar 48mm cover



Area 4 Longitudinal smooth rebar 25.26mm



Area 4 transverse smooth rebar 12.55mm



Appendix E

CHLORIDE CONTENT OF CONCRETE TEST REPORT



BHP/MTIField/F063 V1 08/07/24

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

BHP Ref. No.: 24/07/206
Order No: Not Supplied
Date Tested: 02/09/2024
Test Specification: Customer Spec.
Test Element: Concrete Dust

Project: Mayo Bridges Investigation - Carrowrevagh Bridge
Location Reference: See below
Test Standard: BS 1881 Part 124

Location Reference	Sample Reference	Depth (mm)	Chloride Content % by mass of	
			Sample	Cement
Area 1	24/07/206-8-11	5-30mm	<0.01	<0.02
		30-55mm	<0.01	<0.02
		55-80mm	<0.01	<0.02
		80-105mm	<0.01	<0.02
Area 2	24/07/206-13-16	5-30mm	0.01	0.08
		30-55mm	0.01	0.08
		55-80mm	0.01	0.08
		80-105mm	0.01	0.08
Area 3	24/07/206-18-21	5-30mm	0.01	0.06
		30-55mm	<0.01	<0.02
		55-80mm	<0.01	<0.02
		80-105mm	<0.01	<0.02
Area 5	24/07/206-23-26	5-30mm	<0.01	<0.02
		30-55mm	0.01	0.08
		55-80mm	<0.01	<0.02
		80-105mm	<0.01	<0.02
Area 6	24/07/206-28-31	5-30mm	0.01	0.08
		30-55mm	0.01	0.08
		55-80mm	0.01	0.08
		80-105mm	0.01	0.08

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 maximum allowable of 0.4% (containing embedded steel).

Approved By:	Signature:
Lukasz Zalewski Field Service Manager	

For and On Behalf of BHP Laboratories
Tested by BHP Laboratories, New Road, Thomondgate, Limerick. Phone: (061) 455399 Email: jamespurcell@bhp.ie
Issue Date: 03/09/2024
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 F

CEMENT CONTENT OF CONCRETE TEST REPORT



BHP/MTIField/F056 V1 20/05/24

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

BHP Ref. No.: 24/07/206-12
Order No: Not Supplied
Date Tested: 02/09/2024
Test Specification: Customer Spec.
Test Element: Concrete Dust

Project: Mayo Bridges Investigation - Carrowrevagh Bridge
Location Reference: Area 1
Test Standard: BS 1881 Part 124

Sample Weight (g)	15
Determined Values	
Insoluble residue (%)	68.3
Soluble silica (%)	5.1
Calcium oxide (%)	12.3
Calculated Values	
Cement Content (%)	
ex silica	23.4
ex lime	19.1
preferred / mean value %	19.1
Reported to nearest whole figure (%)	19
Aggregate Content (%)	
ex silica	71.2
ex lime	76.5
preferred / mean value	76.5
Aggregate / Cement Ratio	
ex silica	3
ex lime	4
preferred / mean value	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%

Approved By:	Signature:
Lukasz Zalewski Field Service Manager	

For and On Behalf of BHP Laboratories

Issue Date: 03/09/2024

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

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

BHP Ref. No.: 24/07/206-17
Order No: Not Supplied
Date Tested: 02/09/2024
Test Specification: Customer Spec.
Test Element: Concrete Dust

Project: Mayo Bridges Investigation - Carrowrevagh Bridge
Location Reference: Area 2
Test Standard: BS 1881 Part 124

Sample Weight (g)	16
Determined Values	
Insoluble residue (%)	77.3
Soluble silica (%)	3.6
Calcium oxide (%)	8.5
Calculated Values	
Cement Content (%)	
ex silica	15.6
ex lime	13.2
preferred / mean value %	13.2
Reported to nearest whole figure (%)	13
Aggregate Content (%)	
ex silica	80.8
ex lime	83.8
preferred / mean value	83.8
Aggregate / Cement Ratio	
ex silica	5.2
ex lime	6.4
preferred / mean value	6.4

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%

Approved By:	Signature:
Lukasz Zalewski Field Service Manager	

For and On Behalf of BHP Laboratories

Issue Date: 03/09/2024

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CEMENT CONTENT OF CONCRETE TEST REPORT



BHP/MTIField/F056 V1 20/05/24

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

BHP Ref. No.: 24/07/206-22
Order No: Not Supplied
Date Tested: 02/09/2024
Test Specification: Customer Spec.
Test Element: Concrete Dust

Project: Mayo Bridges Investigation - Carrowrevagh Bridge
Location Reference: Area 3
Test Standard: BS 1881 Part 124

Sample Weight (g)	13
Determined Values	
Insoluble residue (%)	71.6
Soluble silica (%)	4.4
Calcium oxide (%)	11.9
Calculated Values	
Cement Content (%)	
ex silica	20
ex lime	18.4
preferred / mean value %	18.4
Reported to nearest whole figure (%)	18
Aggregate Content (%)	
ex silica	75.4
ex lime	77.3
preferred / mean value	77.3
Aggregate / Cement Ratio	
ex silica	3.8
ex lime	4.2
preferred / mean value	4.2

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%

Approved By:	Signature:
Lukasz Zalewski Field Service Manager	

For and On Behalf of BHP Laboratories

Issue Date: 03/09/2024

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CEMENT CONTENT OF CONCRETE TEST REPORT



BHP/MTIField/F056 V1 20/05/24

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

BHP Ref. No.: 24/07/206-27
Order No: Not Supplied
Date Tested: 02/09/2024
Test Specification: Customer Spec.
Test Element: Concrete Dust

Project: Mayo Bridges Investigation - Carrowrevagh Bridge
Location Reference: Area 5
Test Standard: BS 1881 Part 124

Sample Weight (g)	20
Determined Values	
Insoluble residue (%)	78.9
Soluble silica (%)	3.1
Calcium oxide (%)	7.7
Calculated Values	
Cement Content (%)	
ex silica	13.2
ex lime	11.9
preferred / mean value %	11.9
Reported to nearest whole figure (%)	12
Aggregate Content (%)	
ex silica	83.7
ex lime	85.3
preferred / mean value	85.3
Aggregate / Cement Ratio	
ex silica	6.3
ex lime	7.1
preferred / mean value	7.1

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%

Approved By:	Signature:
Lukasz Zalewski Field Service Manager	

For and On Behalf of BHP Laboratories

Issue Date: 03/09/2024

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CEMENT CONTENT OF CONCRETE TEST REPORT



BHP/MTIField/F056 V1 20/05/24

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

BHP Ref. No.: 24/07/206-32
Order No: Not Supplied
Date Tested: 02/09/2024
Test Specification: Customer Spec.
Test Element: Concrete Dust

Project: Mayo Bridges Investigation - Carrowrevagh Bridge
Location Reference: Area 6
Test Standard: BS 1881 Part 124

Sample Weight (g)	15
Determined Values	
Insoluble residue (%)	74.6
Soluble silica (%)	3
Calcium oxide (%)	9.6
Calculated Values	
Cement Content (%)	
ex silica	12.6
ex lime	14.9
preferred / mean value %	12.6
Reported to nearest whole figure (%)	13
Aggregate Content (%)	
ex silica	84.6
ex lime	81.7
preferred / mean value	84.6
Aggregate / Cement Ratio	
ex silica	6.7
ex lime	5.5
preferred / mean value	6.7

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%

Approved By:	Signature:
Lukasz Zalewski Field Service Manager	

For and On Behalf of BHP Laboratories

Issue Date: 03/09/2024

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

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Appendix G

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



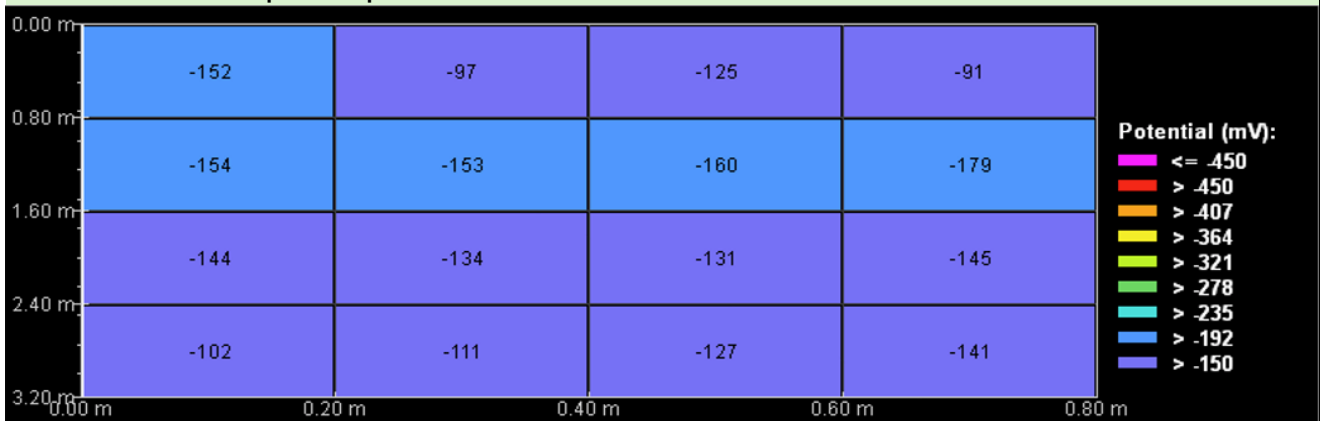
BHP/MTIField/F057 V1 21/05/24

Client:	TRIUR Construction Ltd 13 Society Street Ballinasloe Galway	BHP Ref. No.:	24/07/206-3
		Order No:	Not Supplied
		Date Tested:	29/07/2024
FAO:	Lurcan Donnellan	Test Specification:	Customer Spec.
		Test Element:	Concrete Deck

Project: Mayo Bridges Investigation - Clooycollaran Bridge
Location Reference: Area 3 Soffit
Test Standard: ASTM C876

Test No.	1
No. of Readings	16
Median (mV)	-138
Mean (mV)	-134.1
Standard Deviation	23.7
Lowest (mV)	-179
Highest (mV)	-91
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.

Approved By:	Signature:
Lukasz Zalewski Field Service Manager	

For and On Behalf of BHP Laboratories

Issue Date:

15/08/2024

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	BHP Ref. No.:	24/07/206-3
FAO:	Lurcan Donnellan	Order No:	Not Supplied
Project:	Mayo Bridges - Carrowrevagh Bridge	Date Tested:	30/07/2024
Location Reference:	Area 3	Test Specification:	Client Spec.
Test Standard:	EN 12390-19 2021	Material	Concrete Element

RESULTS				
Structural Element		Soffit		
Measurement Mode		Surface		
Contact Spacing		50mm		
Specimen Shape		Flat		
Dimensions of Test Area (mm)		800x800		
Minimum Measurement (kΩcm)		172		
Maximum Measurement (kΩcm)		280		
Mean Value (kΩcm)		242		
Interpretation of Result		Negligible risk of corrosion		
Resistivity Measurements (kΩcm)				
172	176	273	271	235
270	280	245	242	256
0	0	0	0	0

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:

04/09/2024

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. Calculations



		Project		TO315 Mayo Bridge Assessments 2024		Job ref 100088572	
		Structure No. MO-N59-053.50		Assessment using TII AM-STR-06002 MEXE Method		Calc sheet no. rev 0	
		Drawing Ref		Calc By MK		Date Nov 2024	
Check by MG		Date Nov 2024					
Ref	Calculations					Output	
TII AM-STR-06002	Modified MEXE Method - Span 1						
Span	L in m				1.740		
Rise at Crown	r _c in m				0.920		
Rise at Quarter point	r _q in m				0.810		
Ring Thickness	d in m				0.430		
Depth of fill	h in m				0.180		
Barrel Factor	F _b				1.000		
Fill Factor	F _f	(Well Compacted Material)			0.700		
Joint Width Factor	F _w				0.800		
Joint Mortar Factor	F _{mo}				0.900		
Horizontal Curve Radius	r in m				>600		
$v^2 = \frac{1000 r}{r + 150}$		Centrifugal Effect Factor	F _A	=	1 +	$\frac{0.20 v^2}{r}$	1.000
Joint Depth Factor	F _d				0.100		
Average depth of missing mortar in m					0.100		
Annex G	=>	F _d				0.589	
Condition Factor	F _{cM}				0.800		
	h + d in m				0.610		
	L / r _c				1.891		
From Fig. 3.2 Nonogram	} P.A.L.				70.00		
Provisional Axle Loading		or	740 x	$\frac{(d + h)^2}{L^{1.3}} = P.A.L.$			
From Fig. 3.3	Span/Rise Factor	F _{sr}				1.000	
From Fig. 3.4	Profile Factor	F _p	=	2.3 x [(r _c - r _q)/r _c] ^{0.6}	0.643		
	Material Factor	F _m	=	$\frac{(F_b \times d) + (F_f \times h)}{h + d}$	0.911		
	Joint Factor	F _j	=	F _w x F _{mo} x F _d	0.424		
MODIFIED AXLE LOAD FOR 2-AXLE BOGIE (M.A.L.)		M.A.L.	=	F _{sr} x F _p x F _m x F _j x F _{cM} x P.A.L.	13.920		
AXLE FACTOR (A _f - see Fig 3.5a & 3.5b)		Axle lift-off (Y/N)	☒ N				
Single axle -	1.00	Allowable A.L.				13.9	
2-Axle bogie	1.00	Allowable A.L.				13.9	
3-Axle bogie	1.00	Allowable A.L.				13.9	
LOAD CAPACITY		Max G.V.W in tonnes =				40	

	Project	TO315 Mayo Bridge Assessments 2024		Job ref 100088572				
	Structure No. MO-N59-053.50	Assessment using TII AM-STR-06002 MEXE Method		Calc sheet no.	rev 0			
	Drawing Ref -	Calc By MK	Date Nov 2024	Check by MG	Date Nov 2024			
Ref	Calculations				Output			
TII AM-STR-06002 Modified MEXE Method - Summary <table><tr><td></td><td>Max Gross Vehicle Weight (tonnes)</td></tr><tr><td>MEXE Span 1</td><td>40</td></tr></table>						Max Gross Vehicle Weight (tonnes)	MEXE Span 1	40
	Max Gross Vehicle Weight (tonnes)							
MEXE Span 1	40							

		Project	TO315 Mayo Bridge Assessments 2024		Job ref 100088572		
		Part of Structure MO-N59-053.50		Archie M analysis		Calc sheet no. rev 0	
		Drawing Ref -		Calc By MK	Date Nov 2024	Check by MG	Date Nov 2024
Ref	Calculations					Output	
TII AM-STR-06026 Table 3.1 Table 4.1 Fig 4.3 Table 4.1	<u>Arch Assessment using ArchieM</u>					Remarks 	

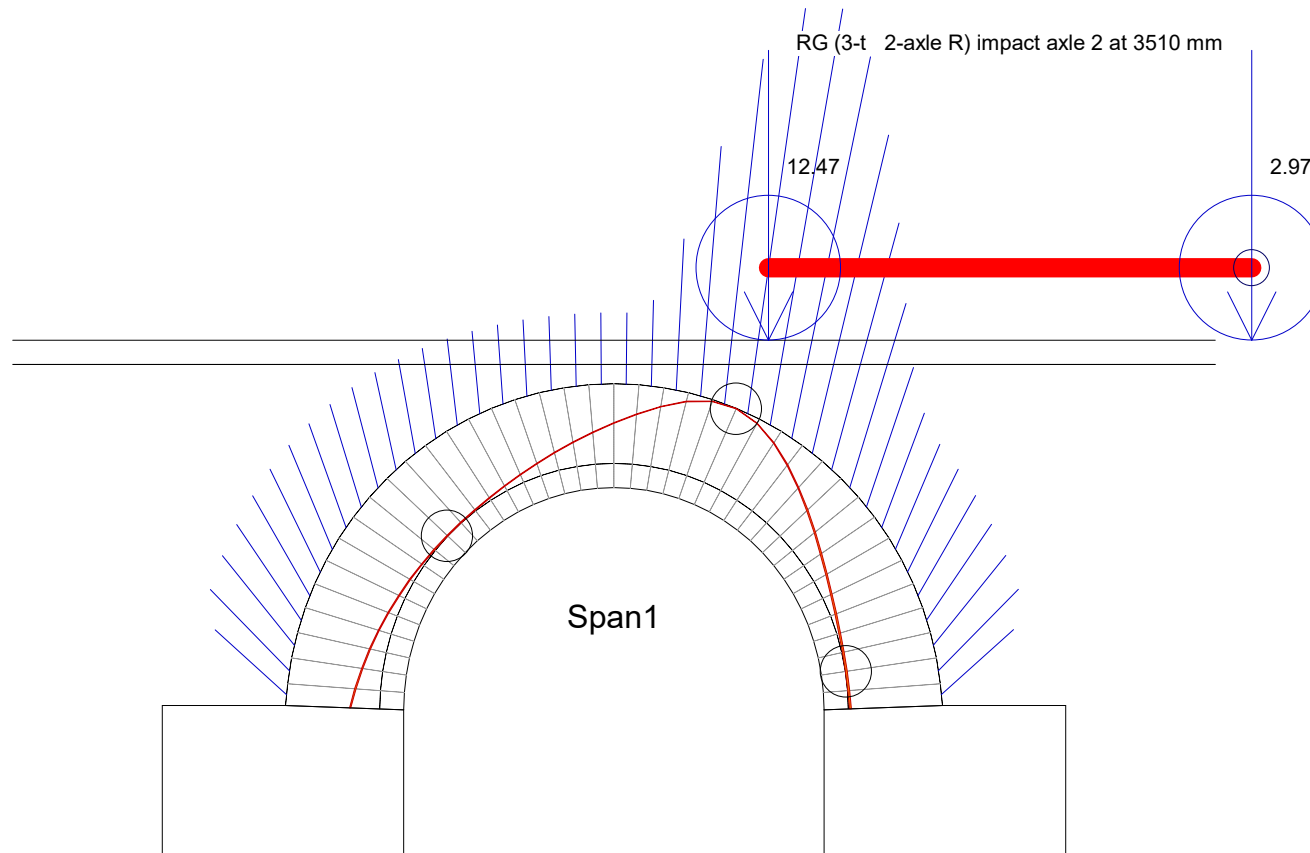


Project	TO315 Mayo Bridge Assessments 2024		Job ref 100088572	
Part of Structure MO-N59-053.50	Archie M analysis		Calc sheet no.	rev 0
Drawing Ref -	Calc By MK	Date Nov 2024	Check by MG	Date Nov 2024

Ref	Calculations		Output																													
TII AM-STR-06026	<u>Details for Archie analysis</u>																															
	<u>Condition factors, in present condition</u>																															
	CI.6.20	γ_{F3} =	1																													
	CI.6.20	γ_m =	1 no other recorded defects which might reduce strength of masonry																													
	Joint width factor	F_w =	0.8																													
	Mortar factor	F_{mo} =	0.9																													
	Average mortar loss	=	0.1 m																													
		F_d =	1.00 taken as 1.0 as mortar loss is modelled directly in Archie																													
		$F_j = (F_w * F_{mo} * F_d)$ =	0.72																													
	- TII AM-STR-06026 Cl. 6.20 gives a combined γ_{FL} factor of 3.4 which is made up a load factor of 1.9 and an impact factor of 1.8. Archie includes the 1.8 impact factor in the load definitions so γ_{FL} is taken as 1.9 in the analysis – γ_{FL} factor is 2.0 for HB & SV load assessments <table><tr><td></td><td></td><td></td><td>HA</td><td>HB & SV</td></tr><tr><td></td><td>γ_{FL}</td><td>=</td><td>1.9</td><td>2</td></tr><tr><td>Centrifugal effect</td><td>F_A</td><td>=</td><td>1.00</td><td>1.00</td></tr><tr><td>Condition factor</td><td>F_{cm}</td><td>=</td><td>0.8</td><td>0.8</td></tr></table> <table><tr><td></td><td></td><td></td><td>HA</td><td>SV</td></tr><tr><td>Effective $\gamma_{FL} = \frac{\gamma_{FL}}{F_j * F_{cm}}$ x F_a =</td><td></td><td></td><td>3.30</td><td>3.47</td></tr></table>						HA	HB & SV		γ_{FL}	=	1.9	2	Centrifugal effect	F_A	=	1.00	1.00	Condition factor	F_{cm}	=	0.8	0.8				HA	SV	Effective $\gamma_{FL} = \frac{\gamma_{FL}}{F_j * F_{cm}}$ x F_a =			3.30
			HA	HB & SV																												
	γ_{FL}	=	1.9	2																												
Centrifugal effect	F_A	=	1.00	1.00																												
Condition factor	F_{cm}	=	0.8	0.8																												
			HA	SV																												
Effective $\gamma_{FL} = \frac{\gamma_{FL}}{F_j * F_{cm}}$ x F_a =			3.30	3.47																												
<u>Condition factors, if repair works are carried out</u>																																
	F_w =	0.8	joint width does not change																													
	F_{mo} =	1																														
	F_d =	1																														
	$F_j = (F_w * F_{mo} * F_d)$ =	0.8																														
<u>best condition γ_{FL} factor</u>																																
			HA	HB & SV																												
	γ_{FL} =	1.9	2																													
	F_A =	1.00	1.00																													
	F_{cm} =	1	1																													
	Effective $\gamma_{FL} =$	2.38	2.50																													

		Project	TO315 Mayo Bridge Assessments 2024		Job ref 100088572																			
		Part of Structure MO-N59-053.50		Archie M analysis		Calc sheet no. rev 0																		
		Drawing Ref -		Calc By MK	Date Nov 2024	Check by MG	Date Nov 2024																	
Ref	Calculations					Output																		
	Summary of Load Cases (Highlighted in bold) Considered in ArchieM Analysis Axle Lift Off: Yes/No? No Case 1: HA Loading 1A : In present condition 1B : In perfect condition 1C : If backing is also present Case 2: SV Loading 2A : In present condition 2B : In perfect condition 2C : If backing is also present Case 3: HB Loading 3A : In present condition 3B : In perfect condition 3C : If backing is also present Summary of Results <table><tr><td>1A</td><td>1B</td><td>1C</td></tr><tr><td>3t</td><td>40t</td><td>n/a</td></tr><tr><td>2A</td><td>2B</td><td>2C</td></tr><tr><td>Fails SV80</td><td>SV196</td><td>n/a</td></tr><tr><td>3A</td><td>3B</td><td>3C</td></tr><tr><td>Fails 30 Units HB</td><td>45 Units HB</td><td>n/a</td></tr></table>					1A	1B	1C	3t	40t	n/a	2A	2B	2C	Fails SV80	SV196	n/a	3A	3B	3C	Fails 30 Units HB	45 Units HB	n/a	
1A	1B	1C																						
3t	40t	n/a																						
2A	2B	2C																						
Fails SV80	SV196	n/a																						
3A	3B	3C																						
Fails 30 Units HB	45 Units HB	n/a																						

Carrowrevagh bridge



3t Vehicle

gammaFI dead load: 1.00 RG (3-t 2-axle R) impact axle 2 @ 3510 [mm]

gammaFI superimposed: 1.00

gammaFI live load: 3.30

gammaF3 load effect: 1.00

gammaM material: 1.00

File path: V:\0088572\7 Calcs\72Model\MO-N59-053.50 Carrowrevagh Bridge_Masonry\Present condition\MO-N59-053.50_HA.brg

NAME: Carrowrevagh bridge

LOCATION: Carrowkennedy, Co.Mayo

NUMBER: MO-N59-053.50

AtkinsRealis

DATE: November 2024

Printed on: Tuesday, November 12, 2024 13:07:55

Bridge Name: Carrowrevagh bridge Bridge Location: Carrowkennedy, Co.Mayo
Bridge Number: MO-N59-053.50
Number of spans: 1

SAFETY FACTORS

Factor for deadload: 1.00 Factor for superimposed deadload: 1.00 Factor for surfacing: 1.00
Factor for live load: 3.30 Factor for load effect: 1.00 Factor for material strength: 1.00

APPLIED LOAD CASES

1. RG (3-t 2-axle R) impact axle 2 Total weight: 29.43 [kN] Position: 3510 [mm]
3.00 2 1.00 0.90 2.00 3.78 0.75 1.80 2.50
Effective lane width: 3647 [mm] Distribution length: 647 [mm]

Applied distribution mode: Archie-M, BD21/97
Applied live load pressure: Active pressure

STRUCTURE PROPERTIES

Road shape: Flat line (1-point method)
Road points: (0, 1530)
Depth of surfacing: 100 Depth of overlay: 0
Surface unit weight: 23.00 [kN/m3] Overlay unit weight: 23.00 [kN/m3]
Lane width: 0

Fill unit weight: 18.00 [kN/m3] Fill phi: 30 degree

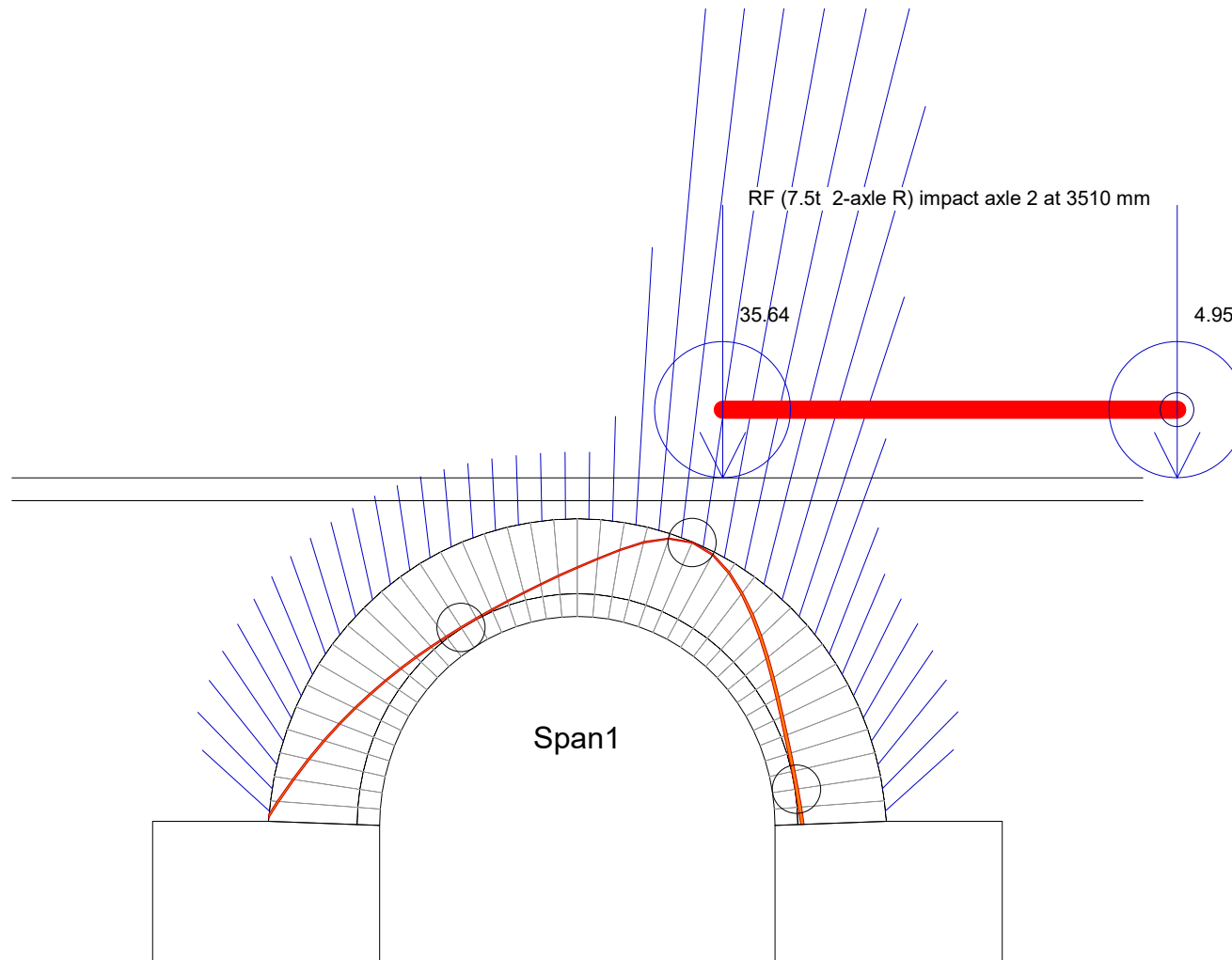
Left abutment Base level:-600 [mm] Height: 0 [mm] Width: 1000 [mm]
Right abutment Base level:-600 [mm] Height: 0 [mm] Width: 1000 [mm]

Right abutment Base level:-600 [mm] Height: 0 [mm] Width: 1000 [mm]
Shape:Elliptic
Span: 1740 [mm] Rise: 920 [mm] Q-rise: 810 [mm]
Ring thickness at crown: 430 [mm] Ring thickness at springing: 490 [mm] Mortar loss: 100 [mm]
Masonry unit weight: 22.00 [kN/m3] Masonry strength: 7.00 [MPa]

Segment	Intrados.x	Intrados.z	Extrados.x	Extrados.z	Road.z	Fx dead	Fz dead	My dead	Fx live	Fz live	My live	Fx passive	Fx total	Fz total	My total	Thrust in	Thrust out	Extra-Thrust
0	0	0	-490	18	1530	0.00	0.00	0.00	0.00	0.00	0.00	-7.24	-37.29	-4.60	120	125	265	
1	3	72	-481	108	1530	1.21	-1.10	-0.23	0.00	-0.00	0.00	0.00	-8.45	-36.19	-3.83	102	107	278
2	11	144	-465	215	1530	1.34	-1.38	-0.29	0.00	-0.00	0.00	0.00	-9.79	-34.81	-3.07	83	88	292
3	24	215	-440	320	1530	1.22	-1.51	-0.31	0.00	-0.00	0.00	0.00	-11.01	-33.30	-2.40	66	71	305
4	43	284	-408	423	1530	1.10	-1.62	-0.31	0.00	-0.00	0.00	0.00	-12.11	-31.68	-1.80	51	56	316
5	66	352	-369	522	1530	0.97	-1.69	-0.31	0.00	-0.00	0.00	0.00	-13.08	-29.99	-1.30	37	42	325
6	95	418	-322	619	1530	0.85	-1.74	-0.30	0.00	-0.00	0.00	0.00	-13.93	-28.25	-0.88	26	30	333
7	128	481	-269	711	1530	0.74	-1.76	-0.29	0.00	-0.00	0.00	0.00	-14.67	-26.49	-0.54	16	20	339
8	166	541	-209	798	1530	0.63	-1.76	-0.27	0.00	-0.00	0.00	0.00	-15.31	-24.74	-0.29	8	12	343
9	208	597	-142	881	1530	0.53	-1.73	-0.24	0.00	-0.00	0.00	0.00	-15.84	-23.00	-0.13	3	7	344
10	255	651	-70	958	1530	0.44	-1.70	-0.22	0.00	-0.00	0.00	0.00	-16.29	-21.30	-0.05	-0	4	344
11	305	700	7	1029	1530	0.36	-1.65	-0.19	0.00	-0.00	0.00	0.00	-16.65	-19.66	-0.05	0	4	341
12	359	744	90	1094	1530	0.29	-1.59	-0.16	0.00	-0.00	0.00	0.00	-16.94	-18.07	-0.12	3	7	335
13	415	784	177	1153	1530	0.23	-1.52	-0.13	0.00	-0.00	0.00	0.00	-17.17	-16.54	-0.27	10	13	326
14	475	820	268	1204	1530	0.18	-1.46	-0.11	0.00	-0.00	0.00	0.00	-17.34	-15.08	-0.48	20	23	314
15	537	850	363	1248	1530	0.13	-1.40	-0.08	0.00	-0.00	0.00	0.00	-17.47	-13.69	-0.76	34	37	298
16	601	875	460	1284	1530	0.10	-1.34	-0.06	0.00	-0.00	0.00	0.00	-17.57	-12.35	-1.09	52	55	278
17	667	895	561	1313	1530	0.07	-1.29	-0.03	0.00	-0.00	0.00	0.00	-17.63	-11.06	-1.49	74	77	255
18	734	909	663	1333	1530	0.04	-1.25	-0.01	0.00	-0.00	0.00	0.00	-17.68	-9.81	-1.94	100	103	228
19	802	917	766	1346	1530	0.02	-1.22	0.01	0.00	-0.00	0.00	0.00	-17.70	-8.59	-2.43	131	134	196
20	870	920	870	1350	1530	0.01	-1.21	0.03	0.00	-0.00	0.00	0.00	-17.71	-7.38	-2.97	167	169	161
21	938	917	974	1346	1530	-0.01	-1.21	0.05	-0.00	-0.00	0.00	0.00	-17.70	-6.18	-3.56	206	209	121

22	1006	909	1077	1333	1530	-0.02	-1.22	0.08	-0.01	-0.23	0.02	0.00	-17.67	-4.72	-4.18	250	252	78
23	1073	895	1179	1313	1530	-0.04	-1.25	0.10	-0.09	-1.31	0.12	0.00	-17.54	-2.16	-4.84	293	295	36
24	1139	875	1280	1284	1530	-0.07	-1.29	0.12	-0.28	-2.94	0.32	0.00	-17.19	2.06	-5.51	324	326	6
25	1203	850	1377	1248	1530	-0.10	-1.34	0.15	-0.56	-4.50	0.55	0.00	-16.54	7.90	-6.10	332	335	-0***
26	1265	820	1472	1204	1530	-0.13	-1.40	0.18	-0.85	-5.46	0.76	0.00	-15.56	14.76	-6.54	315	317	19
27	1325	784	1563	1153	1530	-0.18	-1.46	0.21	-1.05	-5.59	0.86	0.00	-14.34	21.81	-6.72	280	283	56
28	1381	744	1650	1094	1530	-0.23	-1.52	0.24	-1.10	-4.94	0.84	0.00	-13.01	28.27	-6.59	237	241	100
29	1435	700	1733	1029	1530	-0.29	-1.59	0.27	-1.00	-3.80	0.70	0.00	-11.72	33.66	-6.13	194	198	146
30	1485	651	1810	958	1530	-0.36	-1.65	0.30	-0.78	-2.53	0.50	0.00	-10.58	37.84	-5.40	153	158	190
31	1532	597	1882	881	1530	-0.44	-1.70	0.33	-0.51	-1.42	0.30	0.00	-9.63	40.96	-4.48	116	121	230
32	1574	541	1949	798	1530	-0.53	-1.73	0.36	-0.26	-0.63	0.14	0.00	-8.83	43.32	-3.50	83	89	266
33	1612	481	2009	711	1530	-0.63	-1.76	0.38	-0.09	-0.18	0.04	0.00	-8.11	45.26	-2.56	56	62	296
34	1645	418	2062	619	1530	-0.74	-1.76	0.40	-0.01	-0.02	0.00	0.00	-7.36	47.03	-1.75	35	42	321
35	1674	352	2109	522	1530	-0.85	-1.74	0.42	-0.00	-0.00	0.00	0.00	-6.51	48.77	-1.09	19	26	341
36	1697	284	2148	423	1530	-0.97	-1.69	0.43	-0.00	-0.00	0.00	0.00	-5.53	50.47	-0.62	9	16	356
37	1716	215	2180	320	1530	-1.10	-1.62	0.43	-0.01	-0.01	0.00	0.00	-4.43	52.10	-0.32	2	10	366
38	1729	144	2205	215	1530	-1.22	-1.51	0.42	-0.01	-0.01	0.00	0.00	-3.20	53.61	-0.20	-0	8	373
39	1737	72	2221	108	1530	-1.34	-1.38	0.41	-0.01	-0.00	0.00	0.00	-1.85	55.00	-0.27	1	9	376
40	1740	0	2230	18	1530	-1.21	-1.10	0.33	-0.01	-0.00	0.00	0.00	-0.63	56.10	-0.49	5	13	377

Carrowrevagh bridge



7.5t Vehicle

gammaFI dead load: 1.00 RF (7.5t 2-axle R) impact axle 2 @ 3510 [mm]

gammaFI superimposed: 1.00

gammaFI live load: 3.30

gammaF3 load effect: 1.00

gammaM material: 1.00

File path: V:\0088572\7 Calcs\72Model\MO-N59-053.50 Carrowrevagh Bridge_Masonry\Present condition\MO-N59-053.50_HA.brg

NAME: Carrowrevagh bridge

LOCATION: Carrowkennedy, Co.Mayo

NUMBER: MO-N59-053.50

AtkinsRealis

DATE: November 2024

Printed on: Thursday, February 06, 2025 19:19:30

Bridge Name: Carrowrevagh bridge Bridge Location: Carrowkennedy, Co.Mayo
Bridge Number: MO-N59-053.50
Number of spans: 1

SAFETY FACTORS

Factor for deadload: 1.00 Factor for superimposed deadload: 1.00 Factor for surfacing: 1.00
Factor for live load: 3.30 Factor for load effect: 1.00 Factor for material strength: 1.00

APPLIED LOAD CASES

1.RF (7.5t 2-axle R) impact axle 2 Total weight: 73.58 [kN] Position: 3510 [mm]
7.50 2 1.00 1.50 2.00 10.80 1.00 1.80 2.50
Effective lane width: 3647 [mm] Distribution length: 647 [mm]

Applied distribution mode: Archie-M, BD21/97
Applied live load pressure: Active pressure

STRUCTURE PROPERTIES

Road shape: Flat line (1-point method)
Road points: (0, 1530)
Depth of surfacing: 100Depth of overlay: 0
Surface unit weight: 23.00 [kN/m3] Overlay unit weight: 23.00 [kN/m3]
Lane width: 0

Fill unit weight: 18.00 [kN/m3] Fill phi: 30 degree

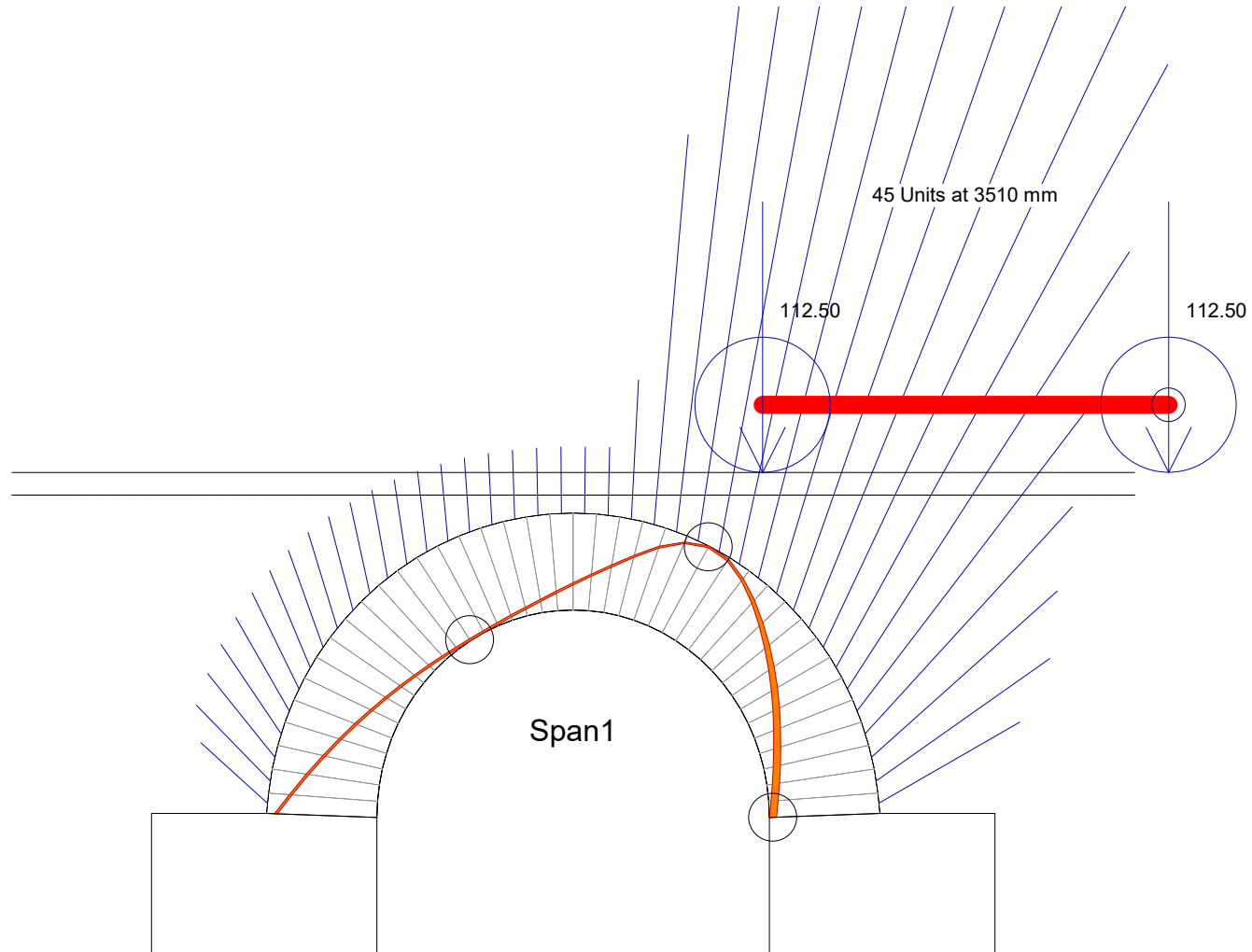
Left abutment Base level:-600 [mm] Height: 0 [mm] Width: 1000 [mm]
Right abutment Base level:-600 [mm] Height: 0 [mm] Width: 1000 [mm]

Right abutment Base level:-600 [mm] Height: 0 [mm] Width: 1000 [mm]
Shape: Elliptic
Span: 1740 [mm] Rise: 920 [mm] Q-rise: 810 [mm]
Ring thickness at crown:430 [mm] Ring thickness at springing: 490 [mm] Mortar loss: 100 [mm]
Masonry unit weight:22.00 [kN/m3] Masonry strength: 7.00 [MPa]

Segment	Intrados.x	Intrados.z	Extrados.x	Extrados.z	Road.z	Fx dead	Fz dead	My dead	Fx live	Fz live	My live	Fx passive	Fx total	Fz total	My total	Thrust in	Thrust out	Extra-Thrust
0 0 0	-490	18	1530	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-30.56	-47.92	-19.77	400407	-17	***	
1 3 72	-481	108	1530	1.21	-1.10	-0.23	0.00	-0.00	0.00	0.00	-31.77	-46.82	-17.26	348355	30			
2 11	144	-465	215	1530	1.34	-1.38	-0.29	0.00	-0.00	0.00	0.00	-33.12	-45.45	-14.75	292299	81		
3 24	215	-440	320	1530	1.22	-1.51	-0.31	0.00	-0.00	0.00	0.00	-34.34	-43.94	-12.41	242250	126		
4 43	284	-408	423	1530	1.10	-1.62	-0.31	0.00	-0.00	0.00	0.00	-35.43	-42.32	-10.24	198205	166		
5 66	352	-369	522	1530	0.97	-1.69	-0.31	0.00	-0.00	0.00	0.00	-36.41	-40.62	-8.27	158165	202		
6 95	418	-322	619	1530	0.85	-1.74	-0.30	0.00	-0.00	0.00	0.00	-37.26	-38.88	-6.49	123130	232		
7 128	481	-269	711	1530	0.74	-1.76	-0.29	0.00	-0.00	0.00	0.00	-38.00	-37.13	-4.92	93	100	259	
8 166	541	-209	798	1530	0.63	-1.76	-0.27	0.00	-0.00	0.00	0.00	-38.63	-35.37	-3.57	66	74	281	
9 208	597	-142	881	1530	0.53	-1.73	-0.24	0.00	-0.00	0.00	0.00	-39.17	-33.63	-2.44	44	52	299	
10 255	651	-70	958	1530	0.44	-1.70	-0.22	0.00	-0.00	0.00	0.00	-39.61	-31.94	-1.53	27	34	314	
11 305	700	7	1029	1530	0.36	-1.65	-0.19	0.00	-0.00	0.00	0.00	-39.97	-30.29	-0.85	13	21	324	
12 359	744	90	1094	1530	0.29	-1.59	-0.16	0.00	-0.00	0.00	0.00	-40.26	-28.70	-0.40	4	12	330	
13 415	784	177	1153	1530	0.23	-1.52	-0.13	0.00	-0.00	0.00	0.00	-40.49	-27.18	-0.17	-0	7	332	
14 475	820	268	1204	1530	0.18	-1.46	-0.11	0.00	-0.00	0.00	0.00	-40.67	-25.72	-0.17	0	7	330	
15 537	850	363	1248	1530	0.13	-1.40	-0.08	0.00	-0.00	0.00	0.00	-40.80	-24.32	-0.40	5	12	323	
16 601	875	460	1284	1530	0.10	-1.34	-0.06	0.00	-0.00	0.00	0.00	-40.89	-22.98	-0.85	15	22	311	
17 667	895	561	1313	1530	0.07	-1.29	-0.03	0.00	-0.00	0.00	0.00	-40.96	-21.70	-1.51	30	37	295	
18 734	909	663	1333	1530	0.04	-1.25	-0.01	0.00	-0.00	0.00	0.00	-41.00	-20.45	-2.39	51	58	273	
19 802	917	766	1346	1530	0.02	-1.22	0.01	0.00	-0.00	0.00	0.00	-41.03	-19.23	-3.47	79	85	245	
20 870	920	870	1350	1530	0.01	-1.21	0.03	0.00	-0.00	0.00	0.00	-41.04	-18.02	-4.75	113	119	211	
21 938	917	974	1346	1530	-0.01	-1.21	0.05	-0.00	-0.00	0.00	0.00	-41.03	-16.81	-6.22	155	160	170	

22	1006	9091077	1333	1530	-0.02	-1.22	0.08	-0.03	-0.66	0.06	0.00	-40.98	-14.93	-7.88	205210120
23	1073	8951179	1313	1530	-0.04	-1.25	0.10	-0.25	-3.75	0.35	0.00	-40.68	-9.93	-9.72	26026666
24	1139	8751280	1284	1530	-0.07	-1.29	0.12	-0.80	-8.40	0.90	0.00	-39.82	-0.25	-11.64	30731320
25	1203	8501377	1248	1530	-0.10	-1.34	0.15	-1.59	-12.85	1.58	0.00	-38.13	13.94	-13.44	329335-0 ***
26	1265	8201472	1204	1530	-0.13	-1.40	0.18	-2.42	-15.61	2.17	0.00	-35.58	30.95	-14.84	31932611
27	1325	7841563	1153	1530	-0.18	-1.46	0.21	-3.00	-15.97	2.46	0.00	-32.41	48.37	-15.57	28729544
28	1381	7441650	1094	1530	-0.23	-1.52	0.24	-3.15	-14.11	2.39	0.00	-29.03	64.01	-15.44	24525388
29	1435	7001733	1029	1530	-0.29	-1.59	0.27	-2.85	-10.86	2.00	0.00	-25.89	76.46	-14.43	200210135
30	1485	6511810	9581530	-0.36	-1.65	0.30	-2.22	-7.24	1.44	0.00	-23.31	85.34	-12.68	157168180	
31	1532	5971882	8811530	-0.44	-1.70	0.33	-1.45	-4.06	0.86	0.00	-21.42	91.10	-10.44	118130221	
32	1574	5411949	7981530	-0.53	-1.73	0.36	-0.75	-1.79	0.40	0.00	-20.14	94.63	-8.02	83 96 259	
33	1612	4812009	7111530	-0.63	-1.76	0.38	-0.25	-0.52	0.12	0.00	-19.25	96.90	-5.73	55 68 291	
34	1645	4182062	6191530	-0.74	-1.76	0.40	-0.03	-0.05	0.01	0.00	-18.48	98.71	-3.79	32 46 317	
35	1674	3522109	5221530	-0.85	-1.74	0.42	-0.00	-0.00	0.00	0.00	-17.63	100.45	-2.31	16 30 337	
36	1697	2842148	4231530	-0.97	-1.69	0.43	-0.01	-0.01	0.00	0.00	-16.65	102.15	-1.31	5 20 351	
37	1716	2152180	3201530	-1.10	-1.62	0.43	-0.01	-0.01	0.00	0.00	-15.54	103.78	-0.81	0 15 361	
38	1729	1442205	2151530	-1.22	-1.51	0.42	-0.01	-0.01	0.00	0.00	-14.31	105.30	-0.81	-0 15 365	
39	1737	72 2221	1081530	-1.34	-1.38	0.41	-0.02	-0.01	0.00	0.00	-12.95	106.68	-1.30	4 20 366	
40	1740	0 2230	18 1530	-1.21	-1.10	0.33	-0.02	-0.00	0.00	0.00	-11.72	107.79	-2.21	13 28 362	

Carrowrevagh Bridge



gammaFI dead load: 1.00 45 Units @ 3510 [mm]

gammaFI superimposed: 1.00

gammaFI live load: 2.50

gammaF3 load effect: 1.00

gammaM material: 1.00

File path: V:\0088572\7 Calcs\72Model\MO-N59-053.50 Carrowrevagh Bridge_Masonry\Present condition\MO-N59-053.50_HB - Good Condition.brg

NAME: Carrowrevagh Bridge

LOCATION: Carrowkennedy, Co.Mayo

NUMBER: MO-N59-053.50

AtkinsRealis

DATE: November 2024

Printed on: Tuesday, November 12, 2024 13:03:31

Bridge Name: Carrowrevagh Bridge Bridge Location: Carrowkennedy, Co.Mayo
Bridge Number: MO-N59-053.50
Number of spans: 1

SAFETY FACTORS

Factor for deadload: 1.00 Factor for superimposed deadload: 1.00 Factor for surfacing: 1.00
Factor for live load: 2.50 Factor for load effect: 1.00 Factor for material strength: 1.00

APPLIED LOAD CASES

1. 45 Units Total weight: 882.90 [kN] Position: 3510 [mm]
90.00 2 1.00 45.00 1.80 45.00 1.00 3.00 3.50
Effective lane width: 4982 [mm] Distribution length: 783 [mm]

Applied distribution mode: Archie-M, BD21/97
Applied live load pressure: Active pressure

STRUCTURE PROPERTIES

Road shape: Flat line (1-point method)
Road points: (0, 1530)
Depth of surfacing: 100 Depth of overlay: 0
Surface unit weight: 23.00 [kN/m3] Overlay unit weight: 23.00 [kN/m3]
Lane width: 0

Fill unit weight: 18.00 [kN/m3] Fill phi: 30 degree

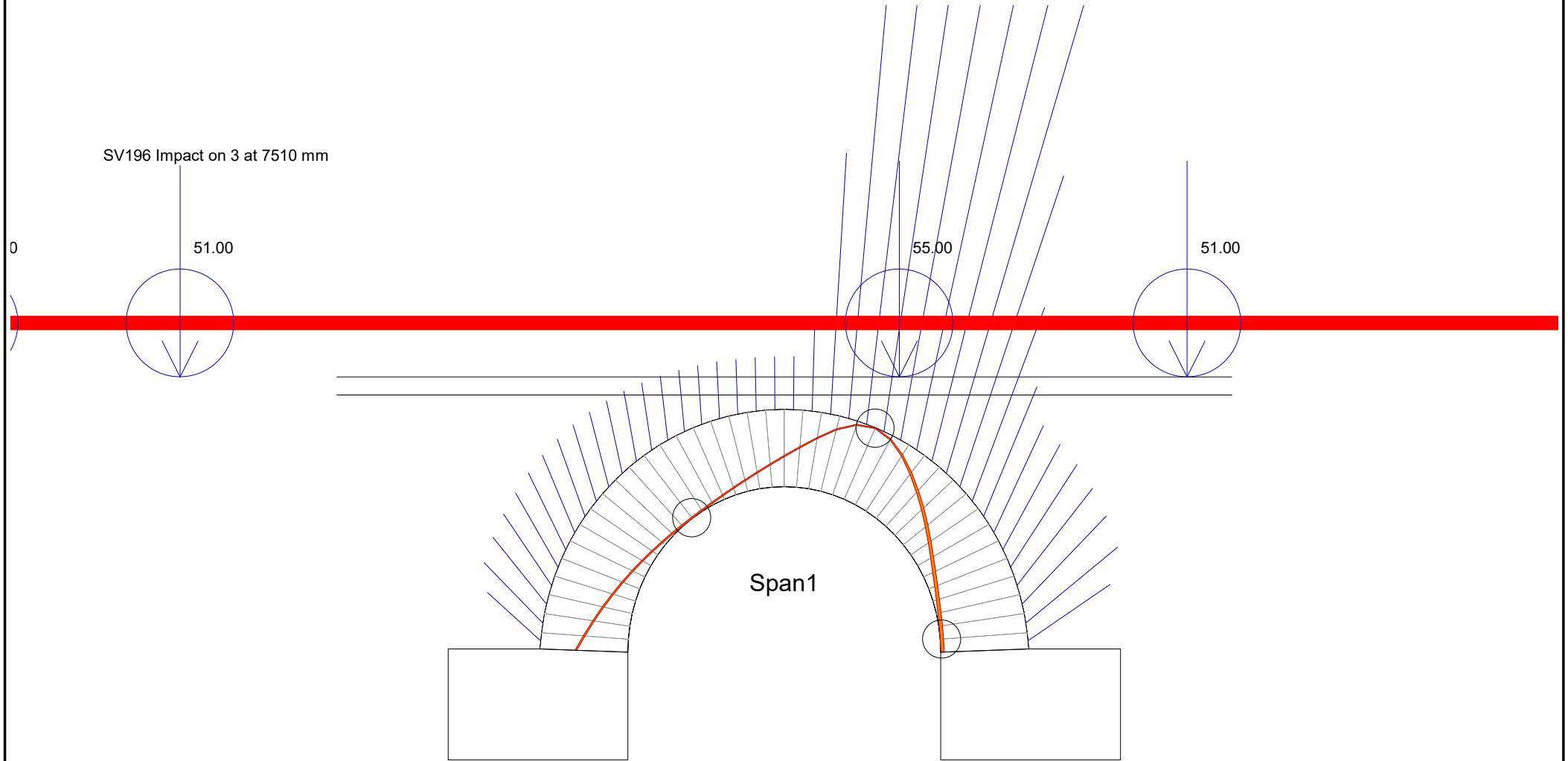
Left abutment Base level:-600 [mm] Height: 0 [mm] Width: 1000 [mm]
Right abutment Base level:-600 [mm] Height: 0 [mm] Width: 1000 [mm]

Right abutment Base level:-600 [mm] Height: 0 [mm] Width: 1000 [mm]
Shape:Elliptic
Span: 1740 [mm] Rise: 920 [mm] Q-rise: 810 [mm]
Ring thickness at crown: 430 [mm] Ring thickness at springing: 490 [mm] Mortar loss: 0 [mm]
Masonry unit weight: 22.00 [kN/m3] Masonry strength: 7.00 [MPa]

Segment	Intrados.x	Intrados.z	Extrados.x	Extrados.z	Road.z	Fx dead	Fz dead	My dead	Fx live	Fz live	My live	Fx passive	Fx total	Fz total	My total	Thrust in	Thrust out	Extra-Thrust
0	0	0	-490	18	1530	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-44.25	-56.52	-26.08	445	453	37
1	3	72	-481	108	1530	1.21	-1.10	-0.25	0.00	-0.00	0.00	0.00	-45.46	-55.42	-22.69	383	391	94
2	11	144	-465	215	1530	1.34	-1.38	-0.32	0.00	-0.00	0.00	0.00	-46.80	-54.05	-19.45	318	326	154
3	24	215	-440	320	1530	1.22	-1.51	-0.34	0.00	-0.00	0.00	0.00	-48.02	-52.54	-16.40	261	270	206
4	43	284	-408	423	1530	1.10	-1.62	-0.36	0.00	-0.00	0.00	0.00	-49.12	-50.92	-13.58	211	220	252
5	66	352	-369	522	1530	0.97	-1.69	-0.36	0.00	-0.00	0.00	0.00	-50.09	-49.22	-10.99	167	176	291
6	95	418	-322	619	1530	0.85	-1.74	-0.35	0.00	-0.00	0.00	0.00	-50.94	-47.48	-8.66	129	138	325
7	128	481	-269	711	1530	0.74	-1.76	-0.33	0.00	-0.00	0.00	0.00	-51.68	-45.73	-6.59	96	105	353
8	166	541	-209	798	1530	0.63	-1.76	-0.31	0.00	-0.00	0.00	0.00	-52.32	-43.97	-4.81	68	78	377
9	208	597	-142	881	1530	0.53	-1.73	-0.29	0.00	-0.00	0.00	0.00	-52.85	-42.23	-3.31	45	55	396
10	255	651	-70	958	1530	0.44	-1.70	-0.26	0.00	-0.00	0.00	0.00	-53.30	-40.54	-2.11	27	37	411
11	305	700	7	1029	1530	0.36	-1.65	-0.22	0.00	-0.00	0.00	0.00	-53.66	-38.89	-1.20	14	23	421
12	359	744	90	1094	1530	0.29	-1.59	-0.19	0.00	-0.00	0.00	0.00	-53.95	-37.30	-0.60	4	14	428
13	415	784	177	1153	1530	0.23	-1.52	-0.16	0.00	-0.00	0.00	0.00	-54.18	-35.78	-0.30	-09	430	
14	475	820	268	1204	1530	0.18	-1.46	-0.13	0.00	-0.00	0.00	0.00	-54.35	-34.32	-0.30	0	9	427
15	537	850	363	1248	1530	0.13	-1.40	-0.10	0.00	-0.00	0.00	0.00	-54.48	-32.92	-0.60	5	14	421
16	601	875	460	1284	1530	0.10	-1.34	-0.07	0.00	-0.00	0.00	0.00	-54.58	-31.58	-1.19	15	24	409
17	667	895	561	1313	1530	0.07	-1.29	-0.04	0.00	-0.00	0.00	0.00	-54.64	-30.30	-2.07	30	39	393
18	734	909	663	1333	1530	0.04	-1.25	-0.02	0.00	-0.00	0.00	0.00	-54.69	-29.05	-3.23	51	59	372
19	802	917	766	1346	1530	0.02	-1.22	0.01	0.00	-0.00	0.00	0.00	-54.71	-27.83	-4.66	78	86	344
20	870	920	870	1350	1530	0.01	-1.21	0.03	0.00	-0.00	0.00	0.00	-54.72	-26.62	-6.35	112	120	310
21	938	917	974	1346	1530	-0.01	-1.21	0.05	-0.00	-0.00	0.00	0.00	-54.71	-25.41	-8.29	154	162	268

22	1006	909	1077	1333	1530	-0.02	-1.22	0.08	-0.00	-0.01	0.00	0.00	-54.69	-24.18	-10.47	206	213	217
23	1073	895	1179	1313	1530	-0.04	-1.25	0.10	-0.09	-1.28	0.15	0.00	-54.56	-21.66	-12.94	269	276	156
24	1139	875	1280	1284	1530	-0.07	-1.29	0.13	-0.55	-5.78	0.73	0.00	-53.94	-14.58	-15.82	339	345	88
25	1203	850	1377	1248	1530	-0.10	-1.34	0.16	-1.54	-12.38	1.81	0.00	-52.31	-0.87	-19.15	399	406	29
26	1265	820	1472	1204	1530	-0.13	-1.40	0.19	-2.97	-19.19	3.20	0.00	-49.21	19.72	-22.80	429	437	-0 ***
27	1325	784	1563	1153	1530	-0.18	-1.46	0.22	-4.61	-24.57	4.60	0.00	-44.42	45.75	-26.46	421	430	9
28	1381	744	1650	1094	1530	-0.23	-1.52	0.25	-6.13	-27.47	5.70	0.00	-38.06	74.75	-29.69	387	397	44
29	1435	700	1733	1029	1530	-0.29	-1.59	0.29	-7.26	-27.64	6.27	0.00	-30.52	103.97	-32.04	340	354	91
30	1485	651	1810	958	1530	-0.36	-1.65	0.32	-7.81	-25.46	6.26	0.00	-22.35	131.08	-33.15	292	308	140
31	1532	597	1882	881	1530	-0.44	-1.70	0.36	-7.76	-21.74	5.74	0.00	-14.14	154.51	-32.83	245	264	187
32	1574	541	1949	798	1530	-0.53	-1.73	0.39	-7.21	-17.33	4.88	0.00	-6.40	173.57	-31.13	202	223	232
33	1612	481	2009	711	1530	-0.63	-1.76	0.42	-6.31	-12.97	3.88	0.00	0.54	188.30	-28.24	162	185	273
34	1645	418	2062	619	1530	-0.74	-1.76	0.44	-5.28	-9.18	2.90	0.00	6.56	199.24	-24.52	126	151	311
35	1674	352	2109	522	1530	-0.85	-1.74	0.45	-4.26	-6.19	2.06	0.00	11.68	207.17	-20.34	94	121	346
36	1697	284	2148	423	1530	-0.97	-1.69	0.46	-3.37	-4.01	1.40	0.00	16.02	212.87	-16.09	67	95	376
37	1716	215	2180	320	1530	-1.10	-1.62	0.46	-2.67	-2.50	0.93	0.00	19.78	216.99	-12.07	43	73	403
38	1729	144	2205	215	1530	-1.22	-1.51	0.45	-2.15	-1.50	0.60	0.00	23.15	220.00	-8.55	25	55	425
39	1737	72	2221	108	1530	-1.34	-1.38	0.43	-1.81	-0.84	0.37	0.00	26.30	222.22	-5.68	10	42	444
40	1740	0	2230	18	1530	-1.21	-1.10	0.34	-1.34	-0.38	0.19	0.00	28.86	223.70	-3.54	0	32	458

Carrowrevagh Bridge



gammaFI dead load: 1.00 SV196 Impact on 3 @ 7510 [mm]

gammaFI superimposed: 1.00

gammaFI live load: 2.50

gammaF3 load effect: 1.00

gammaM material: 1.00

File path: V:\0088572\7 Calcs\72Model\MO-N59-053.50 Carrowrevagh Bridge_Masonry\Present condition\MO-N59-053.50_SV - Good Condition.brg

NAME: Carrowrevagh Bridge

LOCATION: Carrowkennedy, Co.Mayo

NUMBER: MO-N59-053.50

AtkinsRealis

DATE: November 2024

Printed on: Tuesday, November 12, 2024 12:58:53

Bridge Name: Carrowrevagh Bridge Bridge Location: Carrowkennedy, Co.Mayo
Bridge Number: MO-N59-053.50
Number of spans: 1

SAFETY FACTORS

Factor for deadload: 1.00 Factor for superimposed deadload: 1.00 Factor for surfacing: 1.00
Factor for live load: 2.50 Factor for load effect: 1.00 Factor for material strength: 1.00

APPLIED LOAD CASES

1. SV196 Impact on 3Total weight: 2413.26 [kN] Position: 7510 [mm]
246.00 12 1.00 20.40 4.40 20.40 6.00 22.00 10.00 20.40 11.20 20.40 12.40 20.40 13.60 20.40 14.80 20.40 16.00 20.40 17.20 20.40 18.40 20.40 19.60 20.40 1.00 2.65 3.00
Effective lane width: 4497 [mm] Distribution length: 1812 [mm]

Applied distribution mode: Archie-M, BD21/97
Applied live load pressure: Active pressure

STRUCTURE PROPERTIES

Road shape: Flat line (1-point method)
Road points: (0, 1530)
Depth of surfacing: 100 Depth of overlay: 0
Surface unit weight: 23.00 [kN/m3] Overlay unit weight: 23.00 [kN/m3]
Lane width: 0

Fill unit weight: 18.00 [kN/m3] Fill phi: 30 degree

Left abutment Base level:-600 [mm] Height: 0 [mm] Width: 1000 [mm]
Right abutment Base level:-600 [mm] Height: 0 [mm] Width: 1000 [mm]

Right abutment Base level:-600 [mm] Height: 0 [mm] Width: 1000 [mm]
Shape:Elliptic
Span: 1740 [mm] Rise: 920 [mm] Q-rise: 810 [mm]
Ring thickness at crown: 430 [mm] Ring thickness at springing: 490 [mm] Mortar loss: 0 [mm]
Masonry unit weight: 22.00 [kN/m3] Masonry strength: 7.00 [MPa]

Segment	Intrados.x	Intrados.z	Extrados.x	Extrados.z	Road.z	Fx dead	Fz dead	My dead	Fx live	Fz live	My live	Fx passive	Fx total	Fz total	My total	Thrust in	Thrust out	Extra-Thrust
0	0	0	-490	18	1530	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-28.87	-52.72	-15.58	286	294	196
1	3	72	-481	108	1530	1.21	-1.10	-0.25	-0.00	0.00	0.00	0.00	-30.08	-51.62	-13.29	244	251	234
2	11	144	-465	215	1530	1.34	-1.38	-0.32	-0.00	0.00	0.00	0.00	-31.42	-50.25	-11.12	201	209	272
3	24	215	-440	320	1530	1.22	-1.51	-0.34	-0.00	0.00	0.00	0.00	-32.64	-48.73	-9.12	163	170	306
4	43	284	-408	423	1530	1.10	-1.62	-0.36	-0.00	0.00	0.00	0.00	-33.74	-47.12	-7.29	129	137	335
5	66	352	-369	522	1530	0.97	-1.69	-0.36	-0.00	0.00	0.00	0.00	-34.71	-45.42	-5.65	99	107	360
6	95	418	-322	619	1530	0.85	-1.74	-0.35	-0.00	0.00	0.00	0.00	-35.56	-43.68	-4.22	73	81	382
7	128	481	-269	711	1530	0.74	-1.76	-0.33	-0.00	0.00	0.00	0.00	-36.30	-41.93	-3.00	51	59	400
8	166	541	-209	798	1530	0.63	-1.76	-0.31	-0.00	0.00	0.00	0.00	-36.94	-40.17	-1.99	33	41	414
9	208	597	-142	881	1530	0.53	-1.73	-0.29	-0.00	0.00	0.00	0.00	-37.47	-38.43	-1.21	19	26	425
10	255	651	-70	958	1530	0.44	-1.70	-0.26	-0.00	0.00	0.00	0.00	-37.91	-36.74	-0.64	8	16	432
11	305	700	7	1029	1530	0.36	-1.65	-0.22	-0.00	0.00	0.00	0.00	-38.28	-35.09	-0.30	2	10	435
12	359	744	90	1094	1530	0.29	-1.59	-0.19	-0.00	0.00	0.00	0.00	-38.57	-33.50	-0.19	-0	7	434
13	415	784	177	1153	1530	0.23	-1.52	-0.16	-0.00	0.00	0.00	0.00	-38.79	-31.98	-0.29	2	9	430
14	475	820	268	1204	1530	0.18	-1.46	-0.13	-0.00	0.00	0.00	0.00	-38.97	-30.52	-0.60	9	16	421
15	537	850	363	1248	1530	0.13	-1.40	-0.10	-0.00	0.00	0.00	0.00	-39.10	-29.12	-1.13	20	27	407
16	601	875	460	1284	1530	0.10	-1.34	-0.07	-0.00	0.00	0.00	0.00	-39.20	-27.78	-1.86	37	44	389
17	667	895	561	1313	1530	0.07	-1.29	-0.04	-0.00	0.00	0.00	0.00	-39.26	-26.50	-2.79	60	66	366
18	734	909	663	1333	1530	0.04	-1.25	-0.02	-0.00	0.00	0.00	0.00	-39.31	-25.25	-3.91	88	94	336
19	802	917	766	1346	1530	0.02	-1.22	0.01	-0.00	0.00	0.00	0.00	-39.33	-24.03	-5.22	124	130	301
20	870	920	870	1350	1530	0.01	-1.21	0.03	-0.00	0.00	0.00	0.00	-39.34	-22.82	-6.69	167	173	257
21	938	917	974	1346	1530	-0.01	-1.21	0.05	-0.00	-0.00	0.00	0.00	-39.33	-21.61	-8.33	220	225	205

22	1006	909	1077	1333	1530	-0.02	-1.22	0.08	-0.03	-0.83	0.08	0.00	-39.27	-19.56	-10.15	283	288	142
23	1073	895	1179	1313	1530	-0.04	-1.25	0.10	-0.31	-4.69	0.49	0.00	-38.92	-13.62	-12.20	352	357	74
24	1139	875	1280	1284	1530	-0.07	-1.29	0.13	-1.00	-10.51	1.29	0.00	-37.85	-1.82	-14.48	409	414	19
25	1203	850	1377	1248	1530	-0.10	-1.34	0.16	-2.00	-16.08	2.31	0.00	-35.76	15.60	-16.85	429	435	-0 ***
26	1265	820	1472	1204	1530	-0.13	-1.40	0.19	-3.02	-19.53	3.22	0.00	-32.61	36.53	-18.97	409	415	21
27	1325	784	1563	1153	1530	-0.18	-1.46	0.22	-3.75	-19.98	3.70	0.00	-28.68	57.97	-20.45	364	372	67
28	1381	744	1650	1094	1530	-0.23	-1.52	0.25	-3.94	-17.67	3.63	0.00	-24.51	77.16	-20.93	310	320	122
29	1435	700	1733	1029	1530	-0.29	-1.59	0.29	-3.58	-13.65	3.07	0.00	-20.63	92.40	-20.25	257	268	177
30	1485	651	1810	958	1530	-0.36	-1.65	0.32	-2.83	-9.22	2.24	0.00	-17.45	103.27	-18.49	206	219	229
31	1532	597	1882	881	1530	-0.44	-1.70	0.36	-1.92	-5.37	1.40	0.00	-15.08	110.34	-15.93	160	174	277
32	1574	541	1949	798	1530	-0.53	-1.73	0.39	-1.11	-2.67	0.74	0.00	-13.44	114.74	-12.97	120	134	320
33	1612	481	2009	711	1530	-0.63	-1.76	0.42	-0.58	-1.19	0.35	0.00	-12.23	117.69	-10.01	85	100	358
34	1645	418	2062	619	1530	-0.74	-1.76	0.44	-0.39	-0.67	0.21	0.00	-11.10	120.12	-7.35	57	73	390
35	1674	352	2109	522	1530	-0.85	-1.74	0.45	-0.45	-0.65	0.22	0.00	-9.80	122.51	-5.17	35	52	415
36	1697	284	2148	423	1530	-0.97	-1.69	0.46	-0.54	-0.64	0.23	0.00	-8.28	124.85	-3.46	20	37	434
37	1716	215	2180	320	1530	-1.10	-1.62	0.46	-0.62	-0.58	0.22	0.00	-6.56	127.05	-2.25	9	27	449
38	1729	144	2205	215	1530	-1.22	-1.51	0.45	-0.69	-0.48	0.19	0.00	-4.65	129.05	-1.50	3	21	460
39	1737	72	2221	108	1530	-1.34	-1.38	0.43	-0.75	-0.35	0.16	0.00	-2.56	130.78	-1.22	0	19	467
40	1740	0	2230	18	1530	-1.21	-1.10	0.34	-0.65	-0.18	0.09	0.00	-0.70	132.05	-1.35	1	20	470

		Project	MAYO BRIDGE ASSESSMENTS 2024 – EIRSPAN TASK ORDER 315			Job reference		
		Part of Structure	Structure I.D. - MO-N59-053.50 -Carrowrevagh Bridge			Sheet	Rev	
		RC Slab					0	
		Drawing Ref	Assessment using AM-STR-06026	Calc By MK	Date 04-Feb-25	Check by	Date	
		–				MG	04/02/2025	
Ref	Calculations					Output		
	1 Introduction							
	1.1	Spreadsheet Purpose Stage 1 Assessment Calculations of RC Slab Bridge.						
	1.2	Limitations There is no clear Data about the Foundation of the structure.						
	2 Instructions for use							
	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.						
	3 Updates							
	3.1	Previous Updates						
	Revision	Date	Made E	Checked	Description			
	R0	04-Feb-25	MK	MG				

	Project	MAYO BRIDGE ASSESSMENTS 2024 – EIRSPAN TASK ORDER 315			Job Reference	
					100088572	
	Part of Structure	Structure I.D. - MO-N59-053.50-Carrowrevagh Bridge			Sheet Number	Rev.
	RC Slab				2 of 7	0
	Drawing Ref	Assessment using BD21/14 (AM-STR-06026)	Calc By	Date	Checker	Date
–	MK		Feb-25	MG	Feb-25	
	Contents					
	1 General 2 Introduction 3 Material parameters 4 FE Model of Slab 5 Load Calculation 6 Investigations Summary 7 Line beam analysis RC Slab 8 Section Capacity at Midspan (Sagging Moment) 9 Section Capacity Near Support 10 Results Diagram -FEM Analysis					

		Project Name	MAYO BRIDGE ASSESSMENTS 2024 – EIRSPAN TASK ORDER 315			Job Number 100088572							
		Part of Structure	Structure I.D. - MO-N59-053.50-Carrowrevagh Bridge			Sheet Number	Rev.						
		RC Slab				3 of 7	0						
		Drawing Ref	Assessment using BD21/14 (AM-STR-06026)	Originator	Date	Checker	Date						
–	MK	Feb-25		MG	Feb-25								
Ref.	Calculations												
1	<u>General</u> The reinforced concrete slab section of the structure was assessed in accordance with AM-STR-06031 and AM-STR-06026. As per the guidelines of AM-STR-06056 a line beam analysis was carried out using a spreadsheet for the Reinforced slab section. If the strip analysis didn’t show full HA capacity a FEM analysis will be carried out using FEM software. The conservative approach of running the vehicles directly over the slab in Midas without considering the dispersion through the fill, resulted in conservative load effects.												
2	Introduction * The structure is a Slab Bridge * Bridge Square span = 1.85 m * No of span = 1 * The clear skew span = 1.92 m * The average thickness of Top Slab is = 0.246 m * Overall Width between kerbs. = 6.10 m (Including Masonry Arch) * Skew. Angle is = 17 degree * Average Depth of Structural fill = 0.27 m (Total depth of 370mm including surfacing) * Width of the RC section = 3.84 m												
3	Material parameters <table><tr><td>Element</td><td></td><td>f_{ck} (N/mm²)</td></tr><tr><td>RCC Slab</td><td></td><td>56.2</td></tr></table> Grade of steel f_y 230 N/mm² Density of reinforced concrete 25.0 kN/m³ Density of Road surfacing 24.0 kN/m3 Density of Structural fill 20.0 kN/m3							Element		f _{ck} (N/mm ²)	RCC Slab		56.2
Element		f _{ck} (N/mm ²)											
RCC Slab		56.2											

AtkinsRéalis

Project Name

MAYO BRIDGE ASSESSMENTS 2024 – EIRSPAN TASK ORDER 315

Part of Structure

RC Slab

Drawing Ref

–

Job Number

100088572

Sheet Number

3 of 7

Rev.

0

Structure I.D. - MO-N59-053.50-Carrowrevagh Bridge

Assessment using BD21/14 (AM-STR-06026)

Originator

MK

Date

Feb-25

Checker

MG

Date

Feb-25

Ref.

Calculations

AM-STR-06030

Table 1

3.3.2

Partial Safety Factors

For reinforced concrete, the values of γ_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 γ_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 γ_{fl}

ULS: ultimate limit state

SLS: serviceability limit state

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

* γ_{fl} 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.

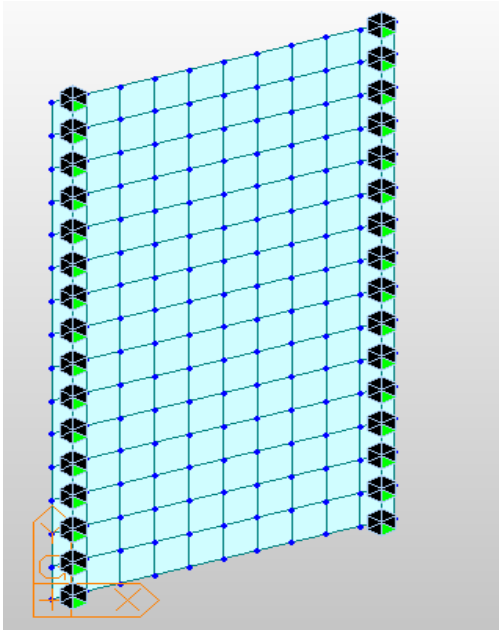
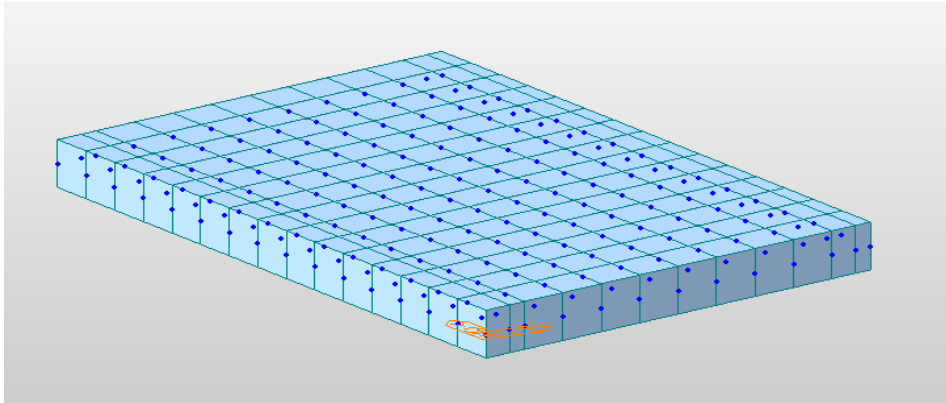
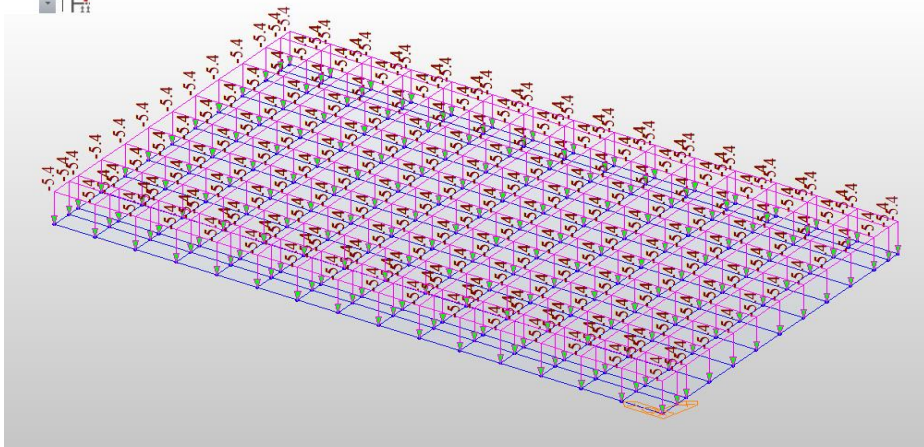
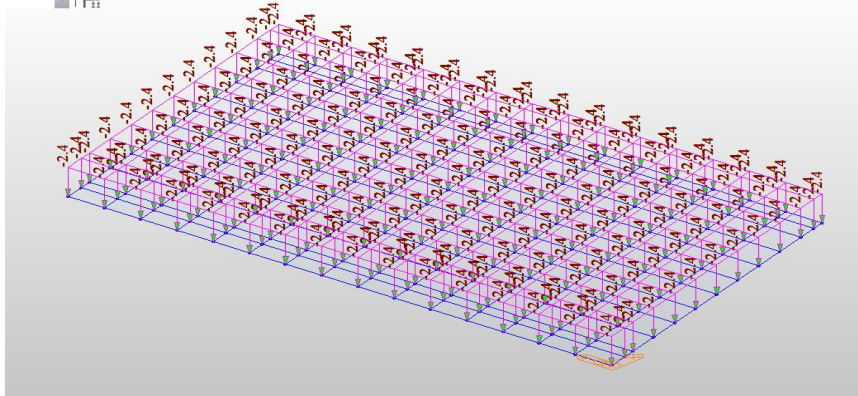
+ γ_{fl} may be reduced to 1.2 and 1.0 for the ULS and SLS respectively subject to approval of the appropriate authority (see 5.2.2.1).

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

Partial Safety Factors for RC Slab Assessment

Load	γ_f for ULS	γ_{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

	Project Name	MAYO BRIDGE ASSESSMENTS 2024 – EIRSPAN TASK ORDER 315			Job Number 100088572	
	Part of Structure	Structure I.D. - MO-N59-053.50-Carrowrevagh Bridge			Sheet Number	Rev.
	RC Slab				3 of 7	0
	Drawing Ref	Assessment using BD21/14 (AM-STR-06026)	Originator	Date	Checker	Date
–	MK		Feb-25	MG	Feb-25	

Ref.	Calculations
4	FE Model of Slab The structure will be analysed as plate model by taking into account the Transverse (Perpendicular to traffic) load distribution . 3D Plate Model 
5	Load Calculation Dead Load Sections are defined in Midas and material property are defined .Self Weight is applied in the Midas. Soil Fill Unit Weight of Soil Fill = 20.0 kN/m3 Depth of infill material = 0.27 m = 5.40 kN/m  Surfacing (Rubbing strips) Weight of Surfacing - 100 mm thick = 1.00 x 0.1 x 1 x 24.0 = 2.40 kN/m 

AtkinsRéalis

Project Name	MAYO BRIDGE ASSESSMENTS 2024 – EIRSPAN TASK ORDER 315			Job Number 100088572	
Part of Structure	Structure I.D. - MO-N59-053.50-Carrowrevagh Bridge			Sheet Number	Rev.
RC Slab				3 of 7	0
Drawing Ref	Assessment using BD21/14 (AM-STR-06026)	Originator	Date	Checker	Date
–		MK	Feb-25	MG	Feb-25

Ref. Calculations

Live Load

Total Carriageway width = 5.65 m (Including the masonry arch)
Number of Notional Lanes considered = 1
(Although the RC slab section covers 0.75m of carriageway we have considered 1 lane conservatively)

The loading to be applied for a Stage 2 Structural Assessment shall be in accordance with the requirements of Chapter 5 of AM-STR-06026.Reduction factors for uniformly distributed load (UDL) and knife-edge load (KEL) shall be in accordance with Chapter 5 of AM-STR-06026 unless otherwise agreed with TII. For a Stage 2 Structural Assessment it is important to establish what component of the loading contributes most to the overall load effect. Therefore, load combinations shall be included for dead load, superimposed dead load and live load in isolation as well as in combination.

The Live Load are defined in the Midas Civil for the following Cases.
Additional cases will be added according to the requirements.

- i) Type HA 40t
- ii) Type HA + HB Combined
- iii) Type HB 45 units
- iv) SV 196

Surface lane Defined in Midas Civil for Live Load

Define Standard Vehicular Load

Standard Name: BD37/01 Standard Load

Vehicular Load Properties

Vehicular Load Name: HB 45

Vehicular Load Type: HB

HB Loading

Pb = 10 kN

D1 = 1.8 m

D2 = 6 m

D3 = D2 + d = 11 m

D4 = D2 + 2d = 16 m

No. of Units: 45

d = 5 m

D5 = D2 + 3d = 21 m

D6 = D2 + 4d = 26 m

Define Standard Vehicular Load

Standard Name: CS 458 (BD86/11) Special Load

Vehicular Load Properties

Vehicular Load Name: SV 196

Vehicular Load Type: SV 196

SV 196

No	P (kN)	D (m)
1	100	4.4
2	180	1.6
3	180	4
4	165	1.2
5	165	1.2

A is Critical of 1.2m or 5.0m or 9.0m

Dynamic Amplification Factor

Auto

Phi: 1

Overload Factor

Auto

Critical Axle: 1.2

All Other Axles: 1.1

Distance to Front and Rear Vehicles

25m

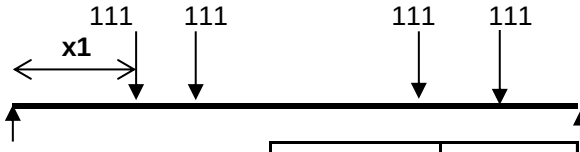
		Project	MAYO BRIDGE ASSESSMENTS 2024 – EIRSPAN TASK ORDER 315		Job ref 100088572	
		Part of Structure	Structure I.D. - MO-N59-053.50 -Carrowrevagh Bridge		Sheet no.	Rev
		RC Slab			4 of 7	0
		Drawing Ref	Calc By	Date	Check by	Date
	MK	04-Feb-25	MG	04-Feb-25		
Ref	Calculations				Output	
6	Investigations Summary: RC Slab					
	CALCULATION OF REBAR SPACING					
	MID SPAN Bottom bar					
	App. C1 /SI Report	Spacing (mm)	MAIN REBAR	TRANS. BAR		
			160	196		
			151	207		
Average rebar spacing		156	202			
DIA of BAR		25	12	mm		
Cover		20	52	mm		
NEAR SUPPORT Bottom bar	App. C1 /SI Report	Spacing (mm)	MAIN REBAR	TRANS. BAR		
			217			
		217		mm		
DIA of BAR		25		mm		
Cover		20				

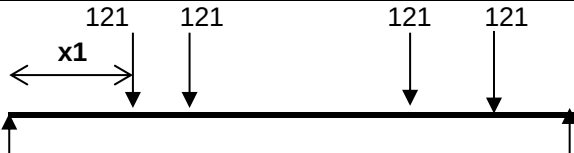
Project MAYO BRIDGE ASSESSMENTS 2024 – EIRSP			Job ref 100088572	
Part of Structure RC Slab			Calc sheet no. rev 0	
Drawing Ref	Calc By MK	Date 04-Feb-25	Check by MG	Date 04-Feb-25

	Project		MAYO BRIDGE ASSESSMENTS 2024 – EIRSPAN TASK ORDER 315		Job ref 10008572																																																							
	Part of Structure		Structure ID - MO-N59-053.50- Carrowrevagh Bri		Calc sheet no. rev																																																							
	RC slab		Assessment using BD21/01		0																																																							
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	—		MK		04/02/25	MG	04-Feb-25																																																					
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AM-STR-06026 & AM-STR-06031 7	Slab Details : Line beam analysis RC Slab <table><tr><td>Depth of slab</td><td>(mm)</td><td>246</td></tr><tr><td>Clear Span</td><td>(m)</td><td>1.92</td></tr><tr><td>Effective Span</td><td>(m)</td><td>2.13</td></tr><tr><td>Slab width</td><td>(mm)</td><td>1000</td></tr><tr><td>Depth of fill above RC Slab</td><td>(mm)</td><td>370</td></tr><tr><td>Condition factor for RC Slab</td><td>-</td><td>0.90</td></tr></table> Spalling of concrete & exposure of rebar					Depth of slab	(mm)	246	Clear Span	(m)	1.92	Effective Span	(m)	2.13	Slab width	(mm)	1000	Depth of fill above RC Slab	(mm)	370	Condition factor for RC Slab	-	0.90																																					
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CI 5.3.1.1 of AM-STR-06031																																																												
SI Report																																																												
CI. 4.4 of AM-STR-06026-02 Table 4A of AM-STR-06031-02																																																												
Material Details : <table><tr><td rowspan="3">Main Tension Steel</td><td>Diameter</td><td>(mm)</td><td>25</td></tr><tr><td>Spacing</td><td>(mm)</td><td>156</td></tr><tr><td>As</td><td>(mm2)</td><td>3157</td></tr><tr><td colspan="2">Concrete cover to tension steel</td><td>(mm)</td><td>20</td></tr><tr><td colspan="2">Secondary reinforcement dia</td><td>(mm)</td><td>12</td></tr><tr><td colspan="2">Is tension steel the outer layer of rebar?</td><td>Y/N</td><td>Y</td></tr><tr><td>effective depth</td><td>d</td><td>(mm)</td><td>214</td></tr><tr><td>Concrete Density</td><td></td><td>kN/m3</td><td>25.0</td></tr><tr><td>Surfacing Density</td><td></td><td>kN/m3</td><td>24.0</td></tr><tr><td>Fill Density</td><td></td><td>kN/m3</td><td>20.0</td></tr><tr><td>Concrete WCS Strength</td><td>WCS, fcu</td><td></td><td>55</td></tr><tr><td>Steel Characteristic Strength</td><td>fy</td><td>(N/mm2)</td><td>230</td></tr><tr><td>Material Factor for Concrete</td><td>Ymc</td><td></td><td>1.20</td></tr><tr><td>Material Factor for Steel</td><td>Yms</td><td></td><td>1.15</td></tr></table>					Main Tension Steel	Diameter	(mm)	25	Spacing	(mm)	156	As	(mm2)	3157	Concrete cover to tension steel		(mm)	20	Secondary reinforcement dia		(mm)	12	Is tension steel the outer layer of rebar?		Y/N	Y	effective depth	d	(mm)	214	Concrete Density		kN/m3	25.0	Surfacing Density		kN/m3	24.0	Fill Density		kN/m3	20.0	Concrete WCS Strength	WCS, fcu		55	Steel Characteristic Strength	fy	(N/mm2)	230	Material Factor for Concrete	Ymc		1.20	Material Factor for Steel	Yms		1.15		
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Calculation of Moment Capacity of Section at Mid Span : <table><tr><td>Estimated Neutral Axis depth</td><td>xu</td><td>(mm)</td><td>85.0</td></tr><tr><td>Assume</td><td>xu</td><td>(mm)</td><td>100.0</td></tr><tr><td>steel strain</td><td>est</td><td></td><td>0.0040</td></tr><tr><td>steel stress</td><td>fst</td><td>(N/mm2)</td><td>200.0</td></tr><tr><td>=></td><td>xu</td><td>(mm)</td><td>23.0</td></tr><tr><td>Is calc. Xu Acceptable</td><td></td><td></td><td>Yes</td></tr><tr><td colspan="2">Avg width of slab up to Neutral Axis</td><td>(mm)</td><td>1000</td></tr><tr><td>z=kd, where</td><td>k=</td><td>(mm)</td><td>0.95</td></tr><tr><td>M. Capacity</td><td>M_C</td><td>(kNm/m)</td><td>115</td></tr></table>					Estimated Neutral Axis depth	xu	(mm)	85.0	Assume	xu	(mm)	100.0	steel strain	est		0.0040	steel stress	fst	(N/mm2)	200.0	=>	xu	(mm)	23.0	Is calc. Xu Acceptable			Yes	Avg width of slab up to Neutral Axis		(mm)	1000	z=kd, where	k=	(mm)	0.95	M. Capacity	M _C	(kNm/m)	115																				
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Calculation of Shear Capacity of Section near supports : Shear checked at 2 locations (i) a_v = d from face of support (with shear enhancement if applicable) (ii) a_v = 2d from face of support (without shear enhancement)																																																												
Table 4A of AM-STR-06031-02	<table><tr><td>100As/b_wd</td><td>-</td><td>-</td><td>1.5</td></tr><tr><td>Depth Factor</td><td>ξ_s</td><td>-</td><td>1.27</td></tr><tr><td>Material FOS for Concrete in Shear</td><td>Ymc</td><td></td><td>1.15</td></tr><tr><td>Ultimate shear stress</td><td>vc</td><td>(N/mm2)</td><td>0.892</td></tr><tr><td>Shear link diameter</td><td>dia.</td><td>mm</td><td>0</td></tr><tr><td>No. Legs</td><td>-</td><td></td><td>0</td></tr><tr><td>Shear link spacing</td><td>sv</td><td>mm</td><td>0</td></tr><tr><td>Asv</td><td>Asv</td><td>mm2</td><td>0.0</td></tr><tr><td>S. capacity concrete</td><td>-</td><td>kN/m</td><td>217</td></tr><tr><td>S. capacity links</td><td>-</td><td>kN/m</td><td>0</td></tr><tr><td>S.Capacity at av = 2d</td><td>V_{C1}</td><td>kN/m</td><td>217</td></tr><tr><td>Shear enhancement allowed?</td><td>Y/N</td><td>-</td><td>Y</td></tr><tr><td>S.Capacity at av = d</td><td>V_{C2}</td><td>kN/m</td><td>651</td></tr></table>					100As/b _w d	-	-	1.5	Depth Factor	ξ _s	-	1.27	Material FOS for Concrete in Shear	Ymc		1.15	Ultimate shear stress	vc	(N/mm2)	0.892	Shear link diameter	dia.	mm	0	No. Legs	-		0	Shear link spacing	sv	mm	0	Asv	Asv	mm2	0.0	S. capacity concrete	-	kN/m	217	S. capacity links	-	kN/m	0	S.Capacity at av = 2d	V _{C1}	kN/m	217	Shear enhancement allowed?	Y/N	-	Y	S.Capacity at av = d	V _{C2}	kN/m	651	Capacity of Section Moment Capacity 114.7 kNm Shear Capacity 217.2 kN/m 651.5 kN/m		
100As/b _w d	-	-	1.5																																																									
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	Project MAYO BRIDGE ASSESSMENTS 2024 – EIRSPAN TASK ORDER 315			Job ref 10008572	
	Part of Structure RC slab	Assessment using BD21/01 RC Slabs		Calc sheet no. rev 0	
	Drawing Ref RC slab	Calc By MK	Date 04/02/25	Check by MG	Date 04-Feb-25
Ref	Calculations				Output
Table 3.1&CI3.9/ AM-STR-06026 CI.4.2.3/AM-STR-06031 Table 3.1&CI3.9/ AM-STR-06026 CI.4.2.3/AM-STR-06031 Table 3.1&CI3.9/ AM-STR-06026 CI.4.2.3/AM-STR-06031 CI. 5.22/AM-STR-06026-02 Figure 5.6 Fig 5.1- AM STR-06026-02 CI 5.24/AM-STR-06026-02 CI 5.27/ BD 21	Line beam analysis RC Slab				Available Capacity for LL Moment 103.6 kNm Shear At 2d 206.7 kN/m At d 636.9 kN/m Bridge Category Mg (HA + KEL Eqv.) Moment Capacity 40t Shear Capacity 40t 40 t Adequacy 162%
	Calculation of Moment due to Permanent Loads at Mid Span &				
	Calculation of Shear due to Permanent Loads near supports:				
	Self weight	Load	(kN/m2)	6.2	
		Yfl		1.15	
		Yf3		1.1	
		Msw	(kNm/m)	4.4	
		Vsw	(kN/m)	8.3	
	Surfacing	Load	(kN/m2)	2.4	
		Yfl		1.75	
		Yf3		1.1	
		Ms	(kNm/m)	2.6	
		Vs	(kN/m)	4.9	
	Fill	Load	(kN/m2)	5.4	
		Yfl		1.20	
		Yf3		1.1	
		Mfill	(kNm/m)	4.1	
		Vfill1	(kN/m)	8	
	Hence, Capacity Available for LL, MCLL		(kNm/m)	104	
	Distance (x) from support to face of support (mm) 107				
	Shear at support	VLLsup	(kN/m)	21	
	Shear at av1 = 2d	VLLav1 = 2d	(kN/m)	10	
	Shear at av2 = d	VLLav2 = d	(kN/m)	15	
	Hence, Capacity Available for LL, VCLL= 2d		(kNm/m)	207	
	Hence, Capacity Available for LL, VCLL= d		(kNm/m)	637	
	Traffic Flows & Surface Condition				
	Annual Average Daily Traffic (Ref P I Report)			2495	
	Percentage of heavy vehicles			7%	
	Annual average hourly HGV flow (AAHHGVF)			7	
	Traffic Flow CI.5.2.2 of BD 21	L/M/H	Medium		
	Condition of road surfacing (Good/ Poor)			Good	
	Therefore Bridge Category			Mg	
	Factor K for 40 tonne loading			0.79	
	HA + KEL and Equiv. 40 t Assessment Loading				
	HA Loading	UDL	(kN/m)	202.2	
		KEL	(kN)	120.0	
	Lane Factor			1.0	
	Adjustment Factor	AF		1.46	
	Therefore, Equivalent 40 t loading	UDL	(kN/m2)	43.77	
		KEL	(kN/m)	25.97	
		Yfl		1.50	
		Yf3		1.1	
	Moment Due 40 tonne loading	MLL	(kNm)	64	
	Shear due to 40t at support	VLLsup	(kN/m)	120	
	Shear due to 40t av = 2d	Vav = 2d	(kN/m)	73	
	Shear due to 40t av = d	VLLav = d	(kN/m)	92	
	Factor C for Moment		1.28	as per Figure 5.6	
	Loading Capacity Moment		40t		
	Factor C for Shear at 2d		1.4	as per Figure 5.6	
	Factor C for Shear at d		6.9		
	Loading Capacity Shear		40t		
	Adequacy Factor for Moment		162%		
	Adequacy Factor for Shear		172%		

	Project		MAYO BRIDGE ASSESSMENTS 2024 – EIRSPAN TASK ORDER 315				Job ref 10008572			
	Part of Structure		Assessment using BD21/01 RC Slabs				Calc sheet no. rev			
	Drawing Ref		Calc By		Date		Check by	Date		
	RC slab		MK		04-Feb-25		MG	04-Feb-25		
Ref	Calculations						Output			
Table 5.3.1 of AM-STR-06026-02	Single Axle Load Line beam analysis R						Moment	Shear	Adequacy	
							Check	Check	for 40t	
	Assessment Loading			(Tonne)	40.0	40.0	40.0			
	Nominal Single Axle Load			(kN)	170	170	170			
	Wheel Contact Area			(m)	0.278	0.278	0.278			
	Minimum Distance Possible from edge of slab to centre line of first wheel in width direction		on left side	(m)	1.50	1.50	1.50			
			on right side	(m)	3.00	3.00	3.00			
			Dispersion for one axle, in transvesre directi		b _{eff}	1.39	1.39	1.39		
	Dispersion for two axle, in transverse directio		b' _{eff}	2.78	2.78	2.78				
	Dispersion in longitudinal direction		b _L	0.65	0.65	0.65				
	=> Load for one axle (P)			kN	170.0	170.0	170.0			
	Load for two axle (P')			kN	340	340	340			
	w = P/b _{eff} b _L assuming load dispersed long. & transve			kN/m ²	189.0	189.0	189.0			
	w' = P'/b' _{eff} b _L assuming load dispersed long. & transv			kN/m ²	189.0	189.0	189.0			
			Yf1		1.50	1.50	1.50			
			Yf3		1.1	1.1	1.1			
	Moment due to one axle		M _{LL}	(kNm)	91	-	91			
	Moment due to two axles		M _{LL}	(kNm)	91	-	91			
	Adequacy Factor				113%	-	113%			
	=>Loading Capacity (Moment)				40t	-	-			
	Shear Due due to one axle at support					171.4	171.4			
	Shear Due due to two axles at support					171.4	171.4			
	Shear due to one axle at av = d		V _{LLav = d}	(kN/m)	-	151	151			
	Shear due to two axle at av = d		V _{LLav = d}	(kN/m)	-	151	151			
	Adequacy Factor				-	421%	421%			
	=>Loading Capacity (Shear) (av = d)				-	40t	-			
	Shear due to one axle at av = 2d		V _{av = 2d}	(kN/m)	-	131	131			
	Shear due to two axles av = 2d		V _{av = 2d}	(kN/m)	-	131	131			
	Adequacy Factor					158%	158%			
	=>Loading Capacity (Shear)(av = 2d)				-	40t	-			
	Table 5.3.1 of BD21	Single Wheel Load						Moment	Shear	Adequacy
								Check	Check	for 40t
		Assessment Loading			(Tonne)	40.0	40.0	40.0		
		Nominal Single Wheel Load			(kN)	86	86	86		
		Wheel Contact Area			(m)	0.280	0.280	0.280		
Minimum Distance Possible from edge of slab to centre line of first wheel		on left side	(m)	1.50	1.50	1.50				
		side	(m)	3.00	3.00	3.00				
		Dispersion for Wheel Load		b _{eff}	0.65	0.65	0.65			
w = P/b _{eff} ² assuming load dispersed long. & transvers			kN/m ²	203.8	203.8	203.8				
		Yf1		1.50	1.50	1.50				
		Yf3		1.1	1.1	1.1				
Moment Due Single Wheel Load		M _{LL}	(kNm)	98.8	-	98.8				
Adequacy Factor				105%	-	105%				
=>Loading Capacity (Moment)				40t	-	-				
Shear Due Single Wheel Load		V _{LL}	(kN)	-	185.2	185.2				
Shear due to 40t av = d		V _{LLav = d}	(kN)	-	163.3	163.3				
Adequacy Factor					390%	390%				
=>Loading Capacity (Shear) (av = d)					40t	-				
Shear due to 40t av = 2d		V _{av = 2d}	(kN)	-	141.5	141.5				
Adequacy Factor					146%	146%				
=>Loading Capacity (Shear)(av = 2d)					40t	-				
FEM analysis Required		Y/N	Y							
As Adequacy factor is only 105% for 40 tonnes loading, a FEM analysis was carried out.										

	Project MAYO BRIDGE ASSESSMENTS 2024 – EIRSPAN TASK ORDER 315			Job ref 10008572	
	Part of Structure RC slab	Assessment using BD21/01 RC Slabs		Calc sheet no. rev 0	
	Drawing Ref RC slab	Calc By MK	Date 04/02/25	Check by MG	Date 04-Feb-25
Ref	Calculations				Output
Table 5.3.1 of BD21	HB Load 				
	Assessment Loading	HB	30.0	45.0	
	Nominal Single Axle Load	(kN)	300	450	
	Wheel Contact Area	(m)	0.261	0.320	
	Minimum Distance Possible from edge of slab to centre line of first wheel	side	(m)	1.50	1.50
		on right	(m)	3.00	3.00
	Dispersion for HB Axle	beff	0.68	0.74	
	=> Load for HB axle	kN	75.0	112.5	
		kN/m	110.8	152.9	
		Yf1	1.50	Moment Factor as per Influence Line ↓ 0.5 0.0 0.0 0.0	
		Yf3	1.1		
	Moment Capacity Check				
	Position of first axle from left support centre	x1	1.07		
	Hence, distance of other axle from left support centre	x2	0.0		
		x3	0.0		
		x4	0.0		
	Moment Due to HB Load	M _{LL}	(kNm)	97	
	Adequacy Factor			106%	
	=>Loading Capacity (Moment)			30HB	
	Shear Capacity Check		for shear at d	for shear at 2d	Shear Factor at 2d
	Position of first axle from left support centre	x1	0.32	0.53	0.85
	Hence, distance of other axle from left support centre	x2	2.1	0.0	0.00
		x3	0.000	0.0	0.00
	Shear Due HB Loading	x4	0.000	0.0	0.00
	Shear at av = d	V _{LLav = d}	(kN/m)	215	HB Load Moment Capacity 30HB Shear Capacity 45HB
	Adequacy Factor			297%	
	=>Loading Capacity (Shear) (av = d)			45HB	
	Shear at av = 2d	V _{av = 2d}	(kN/m)	189	
	Adequacy Factor			109%	
	=>Loading Capacity (Shear)(av = 2d)			45HB	

	Project		MAYO BRIDGE ASSESSMENTS 2024 – EIRSPAN TASK ORDER 315		Job ref 10008572		
	Part of Structure RC slab		Assessment using BD21/01 RC Slabs		Calc sheet no. rev 0		
	Drawing Ref RC slab		Calc By MK		Date 00/01/00	Check by MG	Date 00-Jan-00
Ref	Calculations					Output	
Table 5.3.1 of BD21 AM-STR-06026	SV Load						
							
			Moment	Shear			
	Assessment Loading		SV	80	196		
	Nominal Single Axle Load		(kN)	130	165		
	Wheel Contact Area		(m)	0.123	0.123		
	Minimum Distance Possible from edge of slab to centre line of first wheel						
	side		(m)	1.00	1.00		
	on right		(m)	1.00	1.00		
	Dispersion for SV Axle		beff	0.54	0.54		
	=> Load for SV axle		kN	65.0	82.5		
			kN/m	120.7	153.2	Moment Factor as per Influence Line ↓ 0.1 0.4 0.0 0.0	
			Yfl	1.10			
			Yf3	1.1			
	Moment Capacity Check						
	Position of first axle from left support centre		x1	0.17			
	Hence, distance of other axle from left support		x2	0.8			
			x3	0.0			
			x4	0.0			
	Moment Due to HB Load		M _{LL} (kNm)	67			
	Adequacy Factor			156%			
	=>Loading Capacity (Moment)			SV80			
	Shear Capacity Check		for shear at d	for shear at 2d	Shear Factor at d	Shear Factor at 2d	
	Position of first axle from left support centre		x1	0.33	1.00	0.85	0.5
	Hence, distance of other axle from left support		x2	2.1	0.0	0.00	0.0
			x3	0.000	0.0	0.00	0.0
	Shear Due HB Loading		x4	0.000	0.0	0.00	0.0
	Shear at av = d		V _{LLav = d} (kN/m)	157	HB Load Moment Capacity SV80 Shear Capacity SV196		
	Adequacy Factor			132%			
	=>Loading Capacity (Shear) (av = d)			SV196			
	Shear at av = 2d		V _{av = 2d} (kN/m)	157			
	Adequacy Factor			406%			
	=>Loading Capacity (Shear)(av = 2d)			SV196			
	ASSESSMENT SUMMARY: Line Beam Analysis RC Slab						
	Moment Shear	HA UDL & KEL	Single Axle	Single Wheel	HB	SV	
		40t	40t	40t	30HB	SV80	
40t		40t	40t	45HB	SV196		

	Project	MAYO BRIDGE ASSESSMENTS 2024 – EIRSPAN TASK ORDER 315				Job ref 100088572	
	Part of Structure	Structure I.D. - MO-N59-053.50-Carrowrevagh Bridge				Sheet no.	Rev
	RC Slab					5 of 7	0
	Drawing Ref	Assessment using BD21/14 (AM-STR-0602)	Calc By	Date	Check by	Date	
	—		MK	04/02/25	MG	04-Feb-25	
Ref	Calculations					Output	
8	Section Capcity at Midspan (Sagging Moment)					Capacity of Section Moment Capacity 114.7 kNm Shear Capacity 217.2 kN/m 651.5 kN/m	
BD21/14 (AM-STR-06026)	Slab Details : RC Slab						
BD 44/14 (AM-STR-06031)	Depth of slab		(mm)	246			
	Clear Span		(m)	1.92			
	Slab width		(mm)	1000			
	Depth of fill above RC Slab		(mm)	270			
	Condition factor for RC Slab		-	0.90			
SI Report	Material Details :						
	Main Tension Steel	Diameter	(mm)	25			
		Spacing	(mm)	156			
		As	(mm2)	3157			
	Concrete cover to tension steel		(mm)	20			
	Secondary reinforcement dia		(mm)	12			
	Is tension steel the outer layer of rebar?		Y/N	Y			
	effective depth	d	(mm)	214			
	Concrete Density		kN/m3	25.0			
	Surfacing Density		kN/m3	24.0			
	Fill Density		kN/m3	20.0			
	Concrete WCS Strength	WCS, fcu	(N/mm2)	55			
	Steel Characteristic Strength	fy		230			
	Material Factor for Concrete	Ymc		1.20			
	Material Factor for Steel	Yms		1.15			
Calculation of Moment Capacity of Section							
Estimated Neutral Axis depth	xu	(mm)	82.2				
Assume	xu	(mm)	200.0				
steel strain	est		0.0002				
steel stress	fst	(N/mm2)	47.2				
=>	xu	(mm)	5.4				
Is calc. Xu Acceptable			Yes				
Avg width of slab up to Neutral Axis		(mm)	1000				
z=kd, where	k=	(mm)	0.95				
M. Capacity	M _c	(kNm/m)	115				
Calculation of Shear Capacity of Section near supports :							
Shear checked at 2 locations (i) a _v = d from face of support (with shear enhancement if applicable) (ii) a _v = 2d from face of support (without shear enhancement)							
Table 4A of BD 44/14 (AM-STR-06031)	100As/b _w d	-	-	1.5			
	Depth Factor	ξ _s	-	1.27			
		Ymc		1.15			
	Material FOS for Concrete in Shear						
	Ultimate shear stress	vc	(N/mm2)	0.892			
	Shear link diameter	dia.	mm	0			
	No. Legs	-		0			
	Shear link spacing	sv	mm	0			
	Asv	Asv	mm2	0.0			
	S. capacity concrete	-	kN/m	217			
	S. capacity links	-	kN/m	0			
	S.Capacity at av = 2d	V _{c1}	kN/m	217			
	Shear enhancement allowed?	Y/N	-	Y			
	S.Capacity at av = d	V _{c2}	kN/m	651			

	Project	MAYO BRIDGE ASSESSMENTS 2024 – EIRSPAN TASK ORDER 315		Job ref 100088572		
	Part of Structure	Assessment using BD21/14 (AM-STR-06026)		Sheet no.	Rev	
	RC Slab	Structure I.D. - MO-N59-053.50 -Carrowrevagh Bridge		6 of 7	0	
	Drawing Ref	Calc By	Date	Check by	Date	
	–	VP	04/02/25	MG	04-Feb-25	
	Ref	Calculations			Output	
9	Section Capacity Near Support			Capacity of Section Moment Capacity 82.6 kNm Shear Capacity At 2d At d 194.3 kN/m 583.0 kN/m		
BD21/14 (AM-STR-06026)	Slab Details : RC Slab					
CI 5.3.1.1 of BD 44/14 (AM-STR-06031)	Depth of slab	(mm)	246			
	Clear Span	(m)	1.92			
	Slab width	(mm)	1000			
	Depth of fill above RC Slab	(mm)	270			
	Condition factor for RC Slab	-	0.90			
SI Report	Material Details :					
	Main Tension Steel	Diameter	(mm)			25
		Spacing	(mm)			217
		As	(mm2)			2262
	Concrete cover to tension steel		(mm)			20
	Secondary reinforcement dia		(mm)			12
	Is tension steel the outer layer of rebar?		Y/N			Y
	effective depth	d	(mm)			214
	Concrete Density		kN/m3			25.0
	Surfacing Density		kN/m3			24.0
	Fill Density		kN/m3			20.0
	Concrete WCS Strength	WCS, fcu				55
	Steel Characteristic Strength	fy	(N/mm2)			230
	Material Factor for Concrete	Ymc				1.20
	Material Factor for Steel	Yms				1.15
Calculation of Moment Capacity of Section						
Estimated Neutral Axis depth	xu	(mm)	82.2			
Assume	xu	(mm)	200.0			
steel strain	est		0.0002			
steel stress	fst	(N/mm2)	47.2			
=>	xu	(mm)	3.9			
Is calc. Xu Acceptable			Yes			
Avg width of slab up to Neutral Axis		(mm)	1000			
z=kd, where	k=	(mm)	0.95			
M. Capacity	M _c	(kNm/m)	83			
Calculation of Shear Capacity of Section near supports :						
Shear checked at 2 locations		(i) a _v = d from face of support (with shear enhancement if applicable) (ii) a _v = 2d from face of support (without shear enhancement)				
100As/b _w d	-	-	1.1			
Depth Factor	ξ _s	-	1.27			
Material FOS for Concrete in Shear	Ymc		1.15			
Ultimate shear stress	vc	(N/mm2)	0.798			
Shear link diameter	dia.	mm	0			
No. Legs	-		0			
Shear link spacing	sv	mm	0			
Asv	Asv	mm2	0.0			
S. capacity concrete	-	kN/m	194			
S. capacity links	-	kN/m	0			
S.Capacity at av = 2d	V _{C1}	kN/m	194			
Shear enhancement allowed?	Y/N	-	Y			
S.Capacity at av = d	V _{C2}	kN/m	583			
Table 4A of BD 44/14 (AM-STR-06031)						

	Project Name		MAYO BRIDGE ASSESSMENTS 2024 – EIRSPAN TASK ORDER 315		Job Number 10008572		
	Part of Structure		Structure I.D. - MO-N59-053.50-Carrowrevagh Bridge		Sheet Number		Rev. 0
	RC Slab				7 of 7		
	Drawing Ref		Assessment using BD21/14 (AM-STR-06026)	Originator MK	Date Feb-25	Checker MG	Date Feb-25
–							

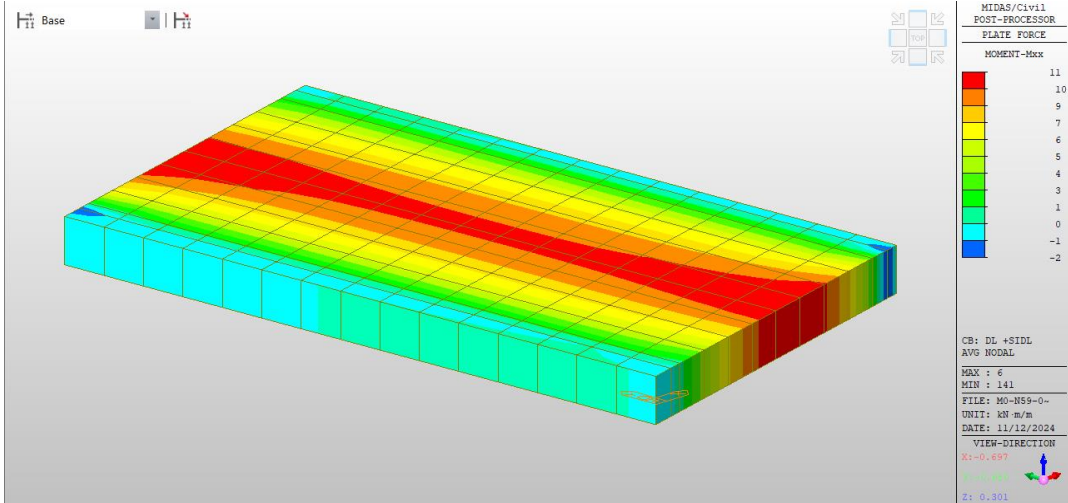
Ref.	Calculations	Output
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10

Results Diagram -FEM Analysis

Dead Load + Super Imposed Dead load (SD*)

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



MIDAS/Civil
POST-PROCESSOR
PLATE FORCE

MOMENT-Mxx

11
10
9
8
7
6
5
4
3
2
1
0
-1
-2

CB: DL +SIDL
AVG NODAL
MAX : 6
MIN : 141
FILE: MO-N59-0-
UNIT: kN-m/m
DATE: 11/12/2024
VIEW-DIRECTION
X1: 0.697
X2: 0.697
X3: 0.301

Maximum of Moment along X axis (Mxx)

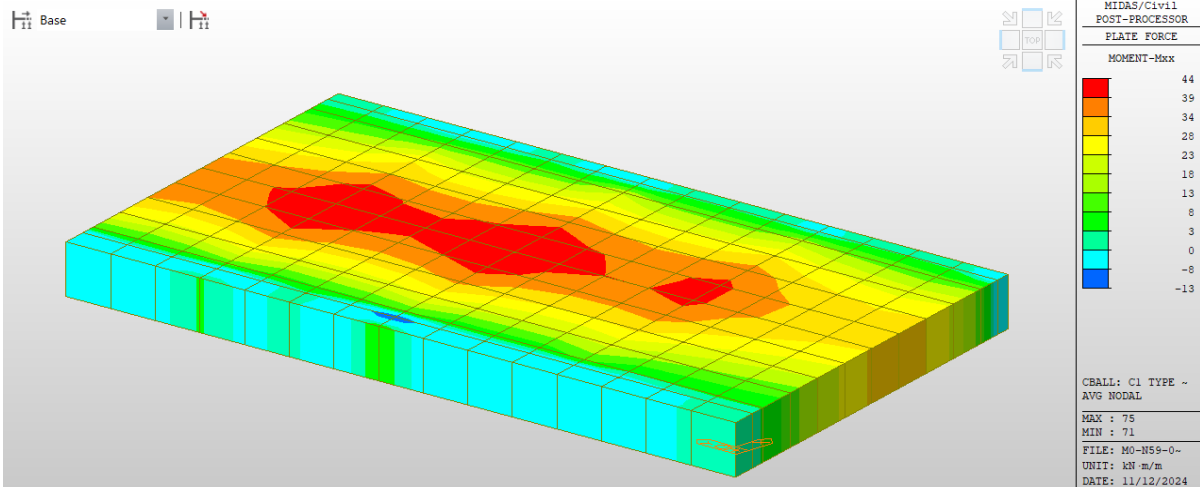
Moment near support = 5 kNm

Maximum Sagging Moment = 15 kNm

Maximum Shear = 66 kN

Load effect due to Type HA 40t Loading - ULS Case 1 (SHA-40T*)

Negligible Hogging moments are produced due to Live Load axles running over the support.



MIDAS/Civil
POST-PROCESSOR
PLATE FORCE

MOMENT-Mxx

44
39
34
28
23
18
13
8
3
0
-8
-13

CBALL: C1 TYPE -
AVG NODAL
MAX : 75
MIN : 71
FILE: MO-N59-0-
UNIT: kN-m/m
DATE: 11/12/2024

Maximum of Moment along X axis (Mxx)

ULS Case 1
(SHA-40T*)

Moment near support = 12 kNm

Maximum Sagging Moment = 44 kNm

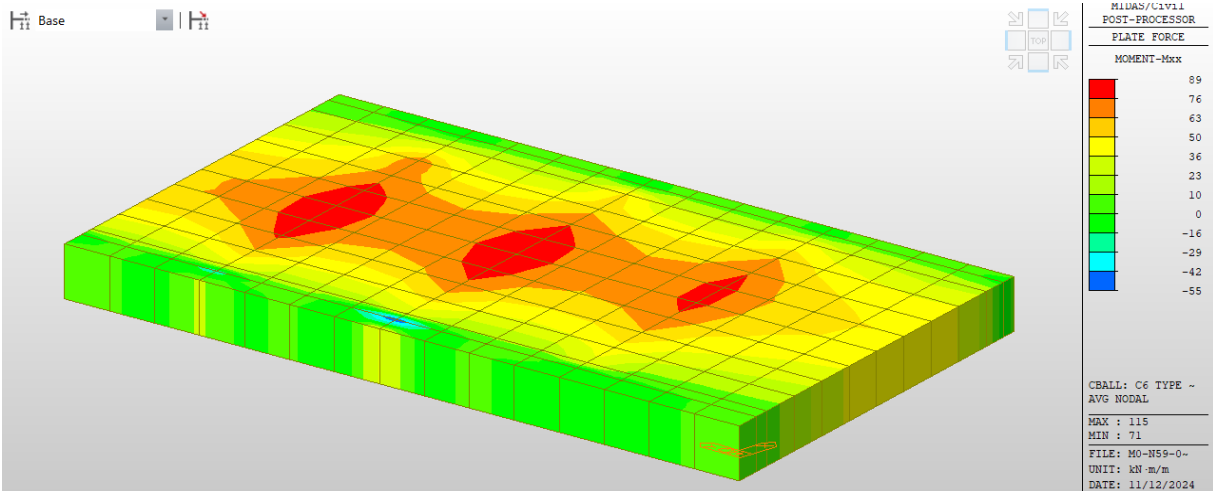
Maximum Shear = 136 kN

	Project Name	MAYO BRIDGE ASSESSMENTS 2024 – EIRSPAN TASK ORDER 315			Job Number 10008572	
	Part of Structure	Structure I.D. - MO-N59-053.50-Carrowrevagh Bridge			Sheet Number	Rev.
	RC Slab				7 of 7	0
	Drawing Ref	Assessment using BD21/14 (AM-STR-06026)	Originator MK	Date Feb-25	Checker MG	Date Feb-25
–						

Ref.	Calculations	Output
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Load effect due to Type HB 45 units Loading-ULS Case 2(SHB45*)

Base

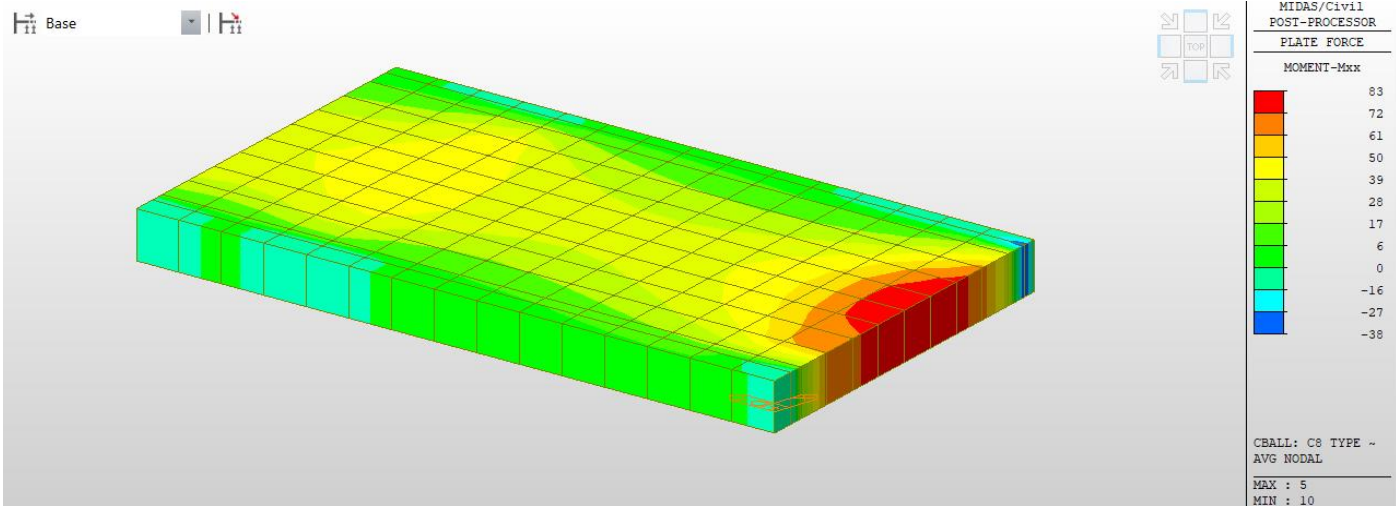


Maximum of Moment along X axis (Mxx)

	ULS Case 2 (SHB-45*)	ULS Case 3 (SHB-30*)
Moment near support	= 19 kNm	15 kNm
Maximum Sagging Moment	= 89 kNm	63 kNm
Maximum Shear	= 217 kN	149 kN

Load effect due to SV 196 Loading - ULS Case 8 (SV 196)

Base



Maximum of Moment along X axis (Mxx)

Moment near support	= 18 kNm
Maximum Sagging Moment	= 83 kNm
Maximum Shear	= 376 kN

	Project Name		MAYO BRIDGE ASSESSMENTS 2024 – EIRSPAN TASK ORDER 315			Job Number	
	Part of Structure		Structure I.D. - MO-N59-053.50-Carrowrevagh Bridge			10008572	
	RC Slab					Sheet Number	
	Drawing Ref		Assessment using BD21/14 (AM-STR-06026)	Originator	Date	Checker	Date
	–			MK	Feb-25	MG	Feb-25

Ref.	Calculations	Output
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Assessment Summary Table.

The Below table shows the results of Critical member governing for each Load effect listed above in the ULS Combination.

Load Effect	RA*	SD*	ULS Case 1 (SHA-40T*)	ULS Case 2 (SHB-45*)	ULS Case 3 (SHB-30*)	ULS Case 7 SSV196*
Moment near support (kNm)	83	5	12	19	15	18
RA*/SA*		16.5	6.9	4.3	5.5	4.6
Check		OK	OK	OK	OK	OK
Max Sagging Moment (kNm)	115	15	44	89	63	83
RA*/SA*		7.6	2.6	1.3	1.8	1.4
Check		OK	OK	OK	OK	OK
Maxm Shear (kN)	583	66	136	217	149	376
RA*/SA*		8.8	4.3	2.7	3.9	1.6
Check		OK	OK	OK	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

RA*/SA* = Structural Assessment Factor

Element	Location in Structure	Load Effect	RA*	SD*	S _{HA40t*}	S _{HB45*}	S _{SV196*}	RA*/SA*
Reinforced Concrete Slab	North	Moment near Support (kNm)	83	5	12	19	18	4.3
		Max. Sagging Moment (kNm)	115	15	44	89	83	1.3
		Max. Shear (kN)	583	66	136	217	376	1.6

Structure ID	Structure Name	Structure Type	No. of Spans	Span Length	Assessed Capacity (ALL)	HB Capacity	SV Capacity
MO-N59-053.50	Carrowrevagh Bridge	RC Slab Bridge	1	1.92	40t	45units	SV196

Appendix E. Sub-Standard Structure Summary

Structure Name: **Carrowrevagh Bridge**

Structure Ref. No.: **MO-N59-053.50**

Assessment/ Review 	Stage:	Stage 1 Assessment				
	Date:	12/11/2024				
	Report Reference:	0088572DG0026				
	Assessed Capacity:	3T GVW (Arch only)				
	Sub-Standard Status:	Provisionally Sub-Standard				
Interim Measures Feasibility Study 	Date:	12/11/2024				
	Is the Structure an Immediate Risk Structure or a Low Risk Provisionally Sub-Standard Structure?	Low Risk Provisionally Substandard Structure				
	Is the Structure Monitoring appropriate?	Yes, the structure is monitoring appropriate				
Interim Measures Proposal 	Date:	12/11/2024				
	Recommendations:	Monitoring on an annual basis until the masonry arch repairs are carried out				



Assessment/ Review	Stage:	Stage 1 Assessment				
Interim Measures Approval	Date: Approval: Approval/Rejection:					
Actions	Implementation Date : Details/Ref : Provisional finish date for monitoring : Removal Date :					
Documentation	Form used: date:	Appendix F 12/11/2024				
Additional Notes	A load restriction to 3t could be considered but considering that there is no evidence of deformation or failure of the arch, monitoring on an annual basis for evidence of deformation or failure is considered most appropriate at this time. Repairs to masonry arch achieves full 40t capacity					



Appendix F. Interim Measures Feasibility Assessment

1. GENERAL DETAILS

1.1 Structure name and assessment reference:

Structure Ref No: Carrowrevagh Bridge MO-N59-053.50

1.2 Location, route and county/area:

N59 National Secondary Road, Carrowkennedy, Co.Mayo

Latitude Y: 774527 Longitude X: 497088

1.3 Assessing Organisation:

Assessed by: AtkinsRealis

Checked by: AtkinsRealis

Assessment date: 12/11/2024

1.4 Structure type, form, span, skew:

The structure consists of two forms of construction. On the southern side of the structure is a single span masonry arch extended by a single span reinforced concrete slab structure.

The single span masonry arch is covered by this Appendix F. Clear span is 1.74m. Width of arch is 7.5m

1.5 Obstacle crossed and facility carried:

Carries the N59 National Secondary Road over an unknown stream in Carrowkennedy, Co.Mayo.

1.6 Estimated cost of permanent strengthening/replacement works:

Repointing of masonry arch structure: €5,000

2. ASSESSMENT PROGRESS

2.1 Level of assessment reached:

Stage 1 Assessment

2.2 Assessed capacity:

Masonry Arch: 3t



2.3 Date of assessment: 12/11/2024

2.4 Assessment Report reference:

0088572DG0026

2.5 Provisionally Sub-standard or Sub-standard?

Provisionally Sub-Standard

2.6 Description of anticipated mode of failure, including its progressions from local overstress to global collapse mechanism.

Mode of failure for the arch is by hinge mechanism caused by the overstress of the arch barrel with initial deformation followed by collapse.

2.7 Description of distress (if present):

No distress currently evident to the arch in the form of deformation, significant defect is pointing loss but this is unrelated to overstress.

3. CONSIDERATION OF RISK POSED BY STRUCTURE IN CURRENT STATE

3.1 Discussion

The bridge has been in similar condition for many years without load restrictions. For this reason, the likelihood of collapse under standard traffic loading is low. The consequence of collapse would be high. Evidence of failure would be by excessive deformation prior to full failure.

The Stage 1 Assessment of the structure in its present condition indicated that the assessment capacity of the arch is 3 tonnes assessment loading. The extent of pointing loss results in a significant decrease of the arch thickness for the assessment model which coupled with the condition rating results in a reduced load capacity.

Masonry repointing to the arch barrel using pinning stones for the larger voids as necessary enables the full depth of the arch barrel to be utilised in the assessment which achieves full 40t loading capacity.

As there is no evidence of deformation to the arch it is likely to have hidden strength not picked up by the Stage 1 Assessment.

3.2 Is the structure an Immediate Risk Structure?

No, the structure is not an Immediate Risk Structure.

3.3 Is the structure a Low Risk Provisionally Sub-standard Structure?

Yes, the structure is a Low Risk Provisionally Sub-standard Structure.



4. APPROPRIATENESS OF MONITORING

4.1 Discussion

Monitoring is considered appropriate.

4.2 Is the structure monitoring appropriate?

Monitoring is considered appropriate. Class 1 monitoring.

5. OPTIONS FOR LOAD MITIGATION INTERIM MEASURES

3 tonnes GVW until the masonry arch is repaired.

6. OPTIONS FOR MONITORING INTERIM MEASURES

Monitoring annually by visual inspection for evidence of deformation or failure of the arch.

7. RECOMMENDED OPTIONS FOR INTERIM MEASURES

7.1 Recommended Load Mitigation Interim Measures:

A load restriction over the structure is not currently recommended but repairs should be undertaken soon

7.2 Recommended Monitoring Interim Measures:

Class 1 monitoring carried out annually.



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