
Constant Energy Limited

Tirawley Wind Farm

Palmerstown Bridge Structural Assessment Report

25th January 2023

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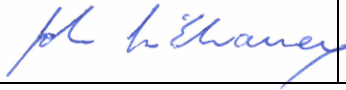
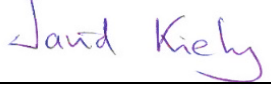
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1. INTRODUCTION

1.1. Terms of Reference

Jennings O'Donovan and Partners Ltd. (JOD) have been appointed by Constant Energy Limited to undertake a structural assessment of an existing bridge on the R314 regional road in Co. Mayo. The bridge is approximately 3.5 km to the northwest of Killala Town and crosses the Cloonaghmore River. The bridge is located on the proposed construction haul route for the Tirawley Wind Farm.

The location of the bridge is indicated in Figure 1 below.

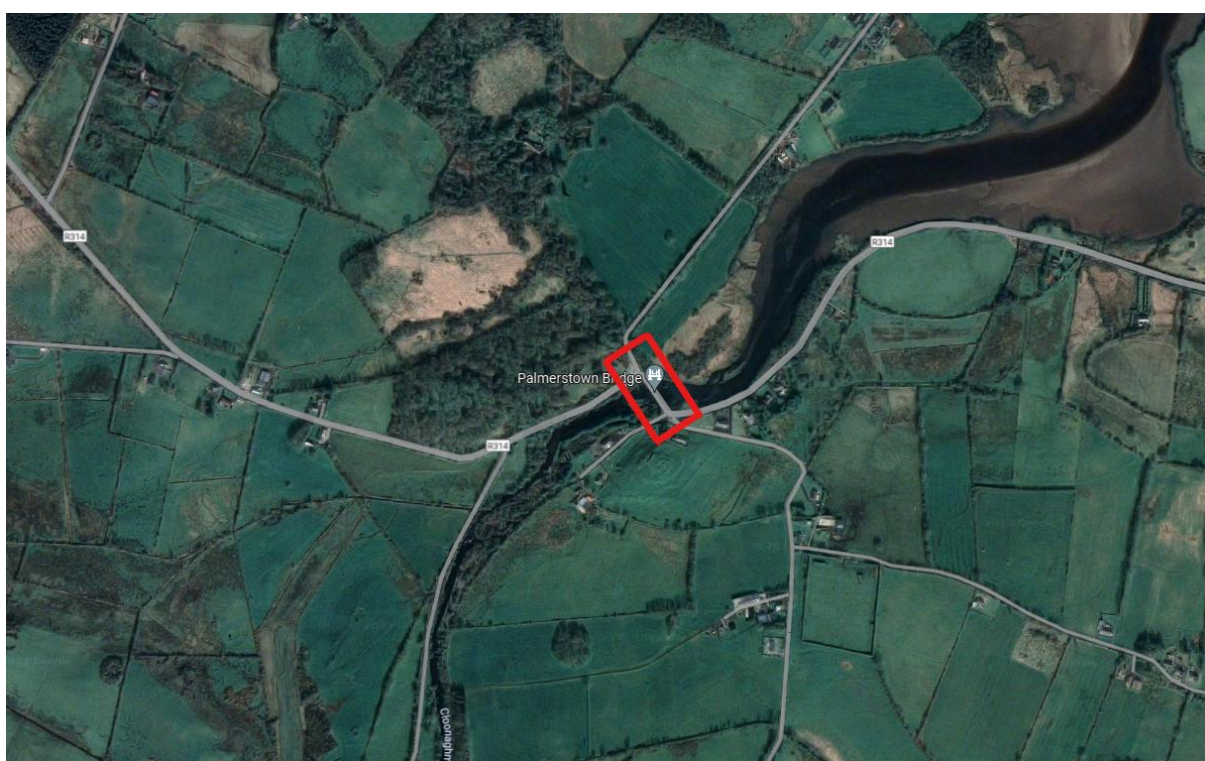


Figure 1 – Bridge Location

The JOD scope of works includes an inspection and report on the existing bridge. This report contains information and comments relating to the structural condition and defects present at the time of an inspection carried out by JOD and an assessment of the structural integrity of the bridge. No opening up of the structures was carried out at the time of the inspections.

The reporting on the bridges follows the same format as set out in the document entitled 'Bridge Asset Management System for Regional and Local Roads', September 2019, developed by the Department of Transport, Tourism and Sport, that sets out Guidelines for;

- Identifying the location of the structure and recording its dimensions – The Bridge Inventory Survey (BIS);
- Assigning an initial rating to the structure – Maintenance Inspections (MI);
- Assigning Component Condition Ratings to individual structure elements (cCR's) and an overall Condition Rating to the Structure – Engineering Inspections (EI).

All naming conventions are as per the above guidelines.

The hydrology industry standard for riverbank and abutment description has been adopted, i.e. the left-hand riverbank (LHB) is always when the observer is facing downstream as indicated in Figure 2 below.

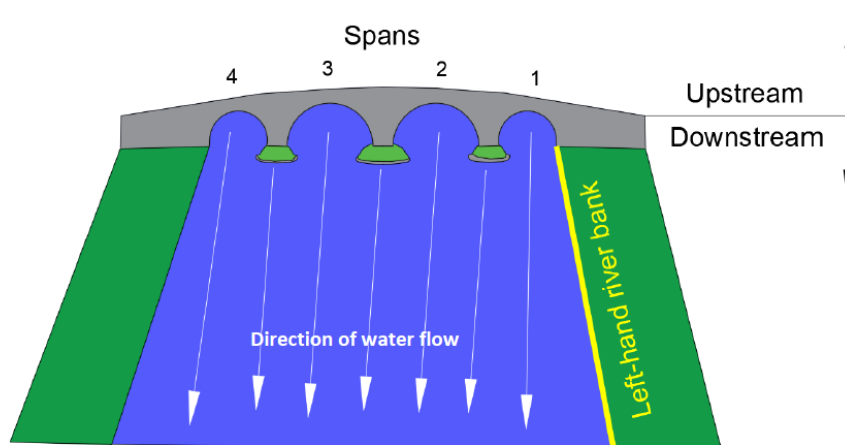


Figure 2 – River Bank and Abutment Description

Figures 3, 4, 5 and 6 below, are taken from the Guidelines noted above and to indicate the various dimensions referenced in this report.



Figure 3 – Total Span

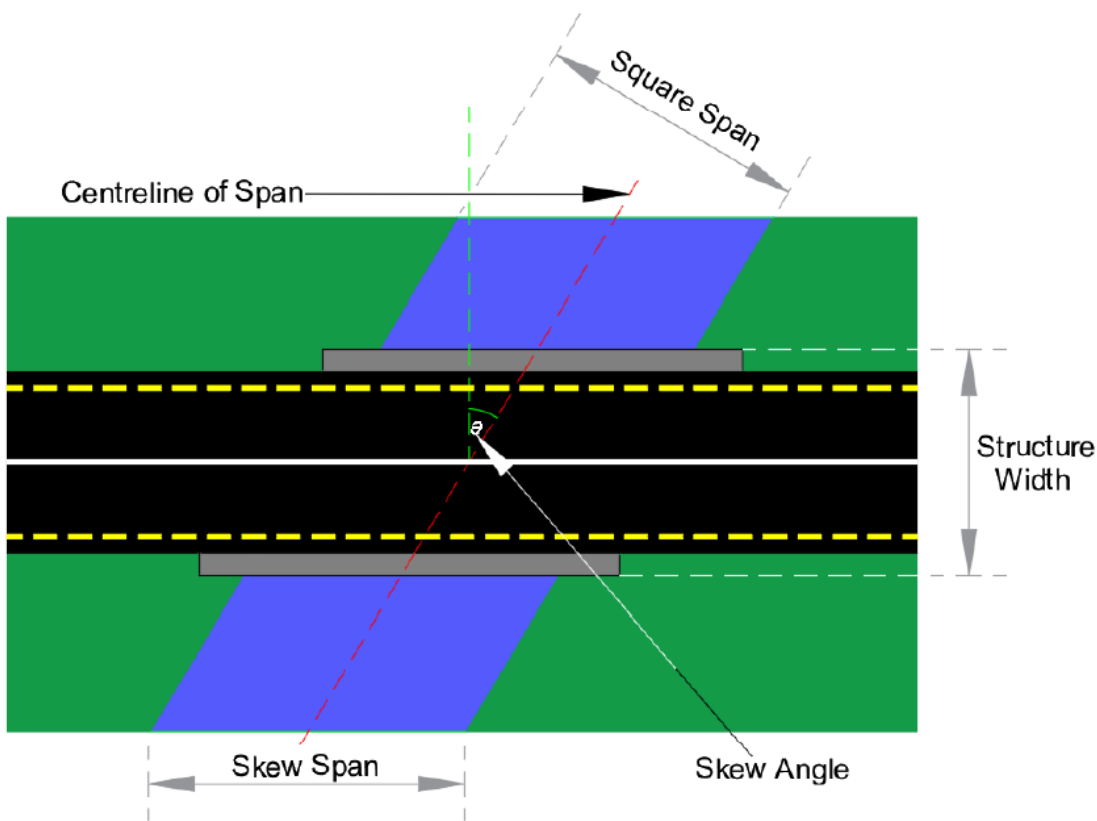


Figure 4 – Span, Width and Skew Angle



Figure 5 – Maximum and Minimum Span

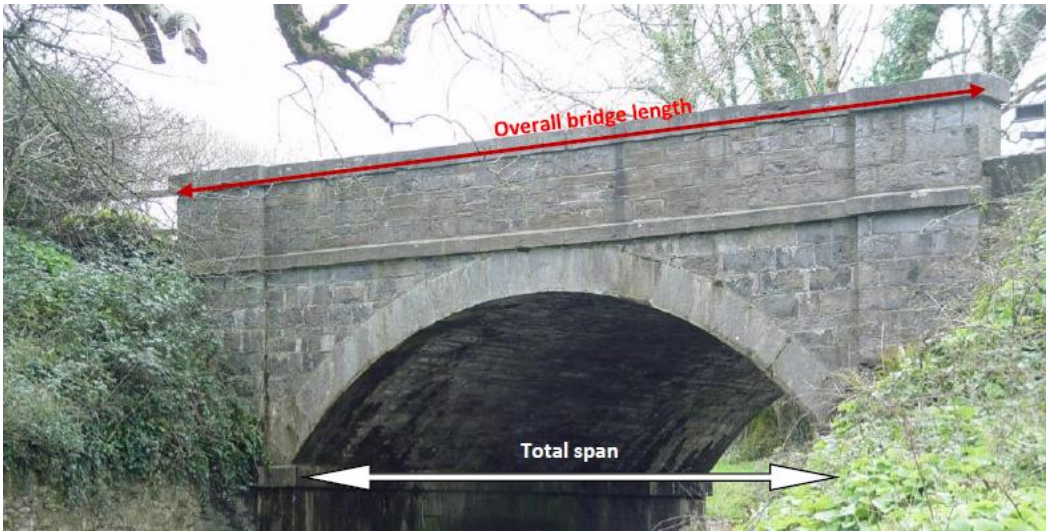


Figure 6 – Overall Bridge Length

2. VISUAL INSPECTION

John McElvaney of JOD carried out visual inspection of the bridge on 10th of January 2023. The inspection included measurement of key dimensions and a record of the condition of the various elements of the bridge.

2.1. Stage 1 – Bridge Inventory Survey

Access Hazard	Deep water; Fast moving water	
Culvert	No	
Structure Type	Arch	
Location	Latitude: 54.225210	Longitude: -9.269215
Road Number	R314	
Structure Number	MO-R314-031.00	
Structure Name (Alias)	Palmerstown Bridge	
Structure Material	Masonry	
Number of Spans	11	
Total Span	49.2 m	
Maximum Span	3.1 m	
Minimum Span	3.1 m	
Structure Length	67.2 m	
Structure Width	5.5 m	
Principle Function	Public Road	
Structure Over	Cloonaghmore River	
Height of Opening	2.4 m (approx.)	
Slew Angle	0°	
Services Present	Yes	
Comments	The bridge is a traditional stone arch structure with stone parapet walls on either side. The carriageway width between parapets is approximately 4.6 m. The parapets are approximately 400 to 450 mm wide by 750 to 900 mm high. The arch is approximately 400 mm deep. The depth of fill above the arch is approximately 600 mm. A watermain is attached to the upstream side of the bridge.	

2.2. Stage 2 – Maintenance Inspection

Maintenance Inspection Rating					
Main Element	Red	Amber	Green	Not Applicable	
Parapets		✓			Non-Structural
Access and Egress			✓		
Vegetation		✓			
External Walls			✓		Structural
Abutments and Piers			✓		
Deck or Arch			✓		
See Appendix 1 for explanation of rating system					

Maintenance Inspection Notes	
Parapets	Vegetation obscures parapet in places. Some minor damage observed. Repairs to parts of the parapets have recently been undertaken.
Access and Egress	Access is OK. Fast flowing and deep water made access to closely inspect the abutments and arches unsafe.
Vegetation	Vegetation on left and right hand ends of upstream parapet / side wall and on left hand side of downstream parapet / side wall.
External Walls	No major issues. Walls are partly obscured by vegetation.
Abutments and Piers	Appeared to be in good condition.
Deck or Arch	Appeared to be in good condition. Road surface in good condition – no defects or rutting apparent.

2.3. Stage 3 – Engineering Inspection

	Component Condition Rating (cCR)				
Component	1	2	3	4	5
	Insignificant Damage (VL)	Some Damage (L) Repair when convenient	Significant Damage (M) Repair needed very soon	Critical Damage (H) Repair needed immediately. Consider load restriction/propping	Ultimate Damage (U) Bridge closure/lane restriction needed
Bridge Surface	✓				
Footpath, Verges, Rubbing Strips, Medians	✓				
Parapets and safety Rails		✓			
Embankment and Revetments	✓				
Wing Walls and Retaining Walls	✓				
Abutments (also see riverbed)	✓				
Piers (also see riverbed)	✓				
Spandrels	✓				
Arch Barrels and External Voussoirs	✓				
Beams / Girders	N/A				
Slab / Deck	N/A				
Riverbed	✓				
Bearings and Expansion Joints	N/A				
OVERALL BRIDGE CONDITION RATING	1	2	3	4	5
See Appendix 2 for explanation of rating system					

Engineering Inspection Notes		
Number	Component	Comment
1	Arch and Abutments	Close inspection of the arches, abutments and piers was not possible on the day of inspection. No obvious defects were observed. We recommend that a close inspection of the underside of the structure is undertaken when water levels are lower.
2	Parapets and Spandrel Walls	Parapets and spandrels walls partly overgrown with vegetation. We recommend that this is removed when convenient.
3	Parapets	Some minor damage and missing stones were observed.

2.4. Photographic Record



Photo No. 2.4.1

Upstream side of bridge from the left riverbank.



Photo No. 2.4.2

Upstream side of bridge from the right riverbank.



Photo No. 2.4.3

Downstream side of bridge from the right riverbank.



Photo No. 2.4.4

Bridge number sign.



Photo No. 2.4.5

General view of bridge from its northern end looking south.



Photo No. 2.4.6

Typical example of repairs carried out on parapet walls.



Photo No. 2.4.7

Typical example of repairs carried out on parapet walls.



Photo No. 2.4.8

Damage observed on downstream parapet wall.



Photo No. 2.4.9

Arch on downstream side of bridge.



Photo No. 2.4.10

Arch on downstream side of bridge. Note arch appears to be in good condition.



Photo No. 2.4.11

Arch on downstream side of bridge. Note arch appears to be in good condition.



Photo No. 2.4.12

Side wall on downstream side in good condition.



Photo No. 2.4.13

Watermain attached to upstream side of bridge. Note vegetation.



Photo No. 2.4.14

Watermain attached to upstream side of bridge. Note vegetation.



Photo No. 2.4.15

Watermain attached to upstream side of bridge.
Note vegetation.



Photo No. 2.4.16

Downstream side wall. Note vegetation.

3. **STRENGTH ASSESSMENT BY MEXE METHOD**

Bridge in its Current Condition

An assessment of the masonry arch has been carried out in accordance with BA 16/97: The Assessment of Highway Bridges and Structures. The assessment uses the modified MEXE method, detailed in Chapter 3 of BA 16/97, and uses the measurements taken on site.

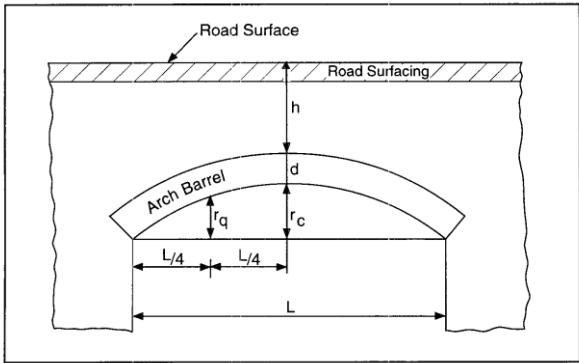


Figure 1 – Bridge dimensions for MEXE method

Arch dimensions used

–	Span, L	=	3.1 m
–	Rise, r _c	=	1.5 m
–	Rise at quarter points, r _q	=	1.3 m
–	Thickness of arch barrel, d	=	0.4 m
–	Average depth of fill, h	=	0.6 m

Provisional Axle Loading (PAL) (BA 3.10)

PAL	=	$[740 \times (d+h)^2] / L^{1.3}$	or 70 (whichever is less)
	=	$[740 \times (0.4+0.6)^2] / 3.1^{1.3}$	or 70 (whichever is less)
	=	170.0	or 70 (whichever is less)

PAL = 70 tonnes

Modifying factors (NRA Design for Roads and Bridges – Assessment of Masonry Arch Bridges by the Modified MEXE Method):

$$\begin{aligned}
 - \text{Span/rise} &= 3.1 / 1.5 = 2.07 \\
 - \text{Span/Rise Factor (F}_{sr}) &= 1.00 \quad (\text{as actual span / rise is less than 4 – figure 3.3})
 \end{aligned}$$

$$\begin{aligned}
 - \text{Profile Factor (F}_p) &= 2.3 [(r_c - r_q) / r_c]^{0.6} \\
 &= 2.3 [(1.5 - 1.3) / 1.5]^{0.6} \\
 &= 0.67
 \end{aligned}$$

$$- \text{Material Factor (F}_m) = [(F_b \times d) + (F_f \times h)] / (d + h)$$

Where:

$$\begin{aligned}
 - \text{Barrel Factor (F}_b) &= 1.0 \quad (\text{Table 3.1}) \\
 - \text{Fill Factor (F}_f) &= 0.7 \quad (\text{Table 3.2})
 \end{aligned}$$

Therefore:

$$\begin{aligned}
 - \text{Material Factor (F}_m) &= [(1.0 \times 0.4) + (0.7 \times 0.6)] / (0.4 + 0.6) \\
 &= 0.82
 \end{aligned}$$

$$- \text{Joint Factor (F}_j) = F_w \times F_d \times F_{mo}$$

Where:

$$\begin{aligned}
 - \text{Width Factor (F}_w) &= 0.9 \quad (\text{Table 3.3}) \\
 - \text{Mortar Factor (F}_{mo}) &= 0.9 \quad (\text{Table 3.4) – Shotcrete to arch soffit}) \\
 - \text{Depth Factor (F}_d) &= 0.8 \quad (\text{Table 3.5})
 \end{aligned}$$

Therefore:

$$\begin{aligned}
 - \text{Joint Factor (F}_j) &= 0.9 \times 0.9 \times 0.8 \\
 &= 0.65
 \end{aligned}$$

$$- \text{Condition factor (F}_{cM}) = 0.9 \quad (\text{based on proven capacity and good condition})$$

$$- \text{Axle Factors (A}_f) = 1.0 \quad (\text{Figure 3.5a) (no axle lift-off)})$$

$$\begin{aligned}
 \text{Modified Axle Loading} &= F_{sr} \times F_p \times F_m \times F_j \times F_{cM} \times \text{PAL} \\
 &= 1 \times 0.67 \times 0.82 \times 0.65 \times 0.9 \times 70.0 \\
 &= \mathbf{22.5 \text{ tonnes}}
 \end{aligned}$$

It should be noted that this capacity is for the arch alone, and that the capacity of the full bridge is a combination of several other elements including fill materials, buttresses and foundations. It should also be noted that this method can return quite variable results as the modifying factors are subjective.

Due to the span and generally good condition of the arch, it is within the parameters of the MEXE calculation method. Accordingly, it is concluded that currently this arch is capable of supporting the maximum axial load applied by movement of standard roadworthy vehicles.

4. CONCLUSIONS & RECOMMENDATIONS

In general, the bridge is currently in a good structural condition. Our assessment indicates that the bridge is capable carrying the loads exerted on it by standard roadworthy vehicles.

The arches have not lost their shape and the joints, as observed, appeared to be even.

It was not possible to ascertain the condition or nature of the foundations or formation soils during the inspection. These, however, appear to be performing adequately.

The upstream and downstream parapet walls range in height from approximately 750 mm to 900 mm.

The Modified MEXE Method concludes an axle load capacity of 22.5 tonnes for the bridge in its current state. This assumes that there is no axle lift off. Accordingly, it is concluded that the bridge is capable of supporting the maximum axial load applied by standard roadworthy vehicles.

We also conclude that the bridge is capable of supporting wind farm traffic to the proposed Tirawley Wind Farm.

The carriageway width between the parapets is 4.6 m. This should be checked against any abnormal delivery loads to confirm if it is sufficient. Abnormal loads for the delivery of turbine components have been assessed in the Turbine Delivery Route Report, refer to **Appendix 17.1** of the EIAR.

Appendix 1
Maintenance Inspection Rating System

Appendix 2
Component Condition Rating System