# APPENDIX 4-6

## *BRIDGE CROSSING STRUCTURAL ASSESSMENT REPORT*

# PROPOSED SESKIN WIND FARM TURBINE DELIVERY ROUTE, COUNTY CARLOW

## Bridge Crossing
## Structural Assessment Report

**December 2023**

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# ***DOCUMENT APPROVAL***

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| Date<br>08/12/2023 | Signature | Signature | Signature |

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# 1 INTRODUCTION



## Terms of Reference

Jennings O'Donovan & Partners Limited have been engaged by EDF Renewables Ireland Limited to conduct a preliminary structural inspection on an existing bridge crossing, located on a local road, between the N78 National road and the M9 motorway, on Carlow – Kilkenny county border. The bridge location is indicated by the red circle in figure 1 below.

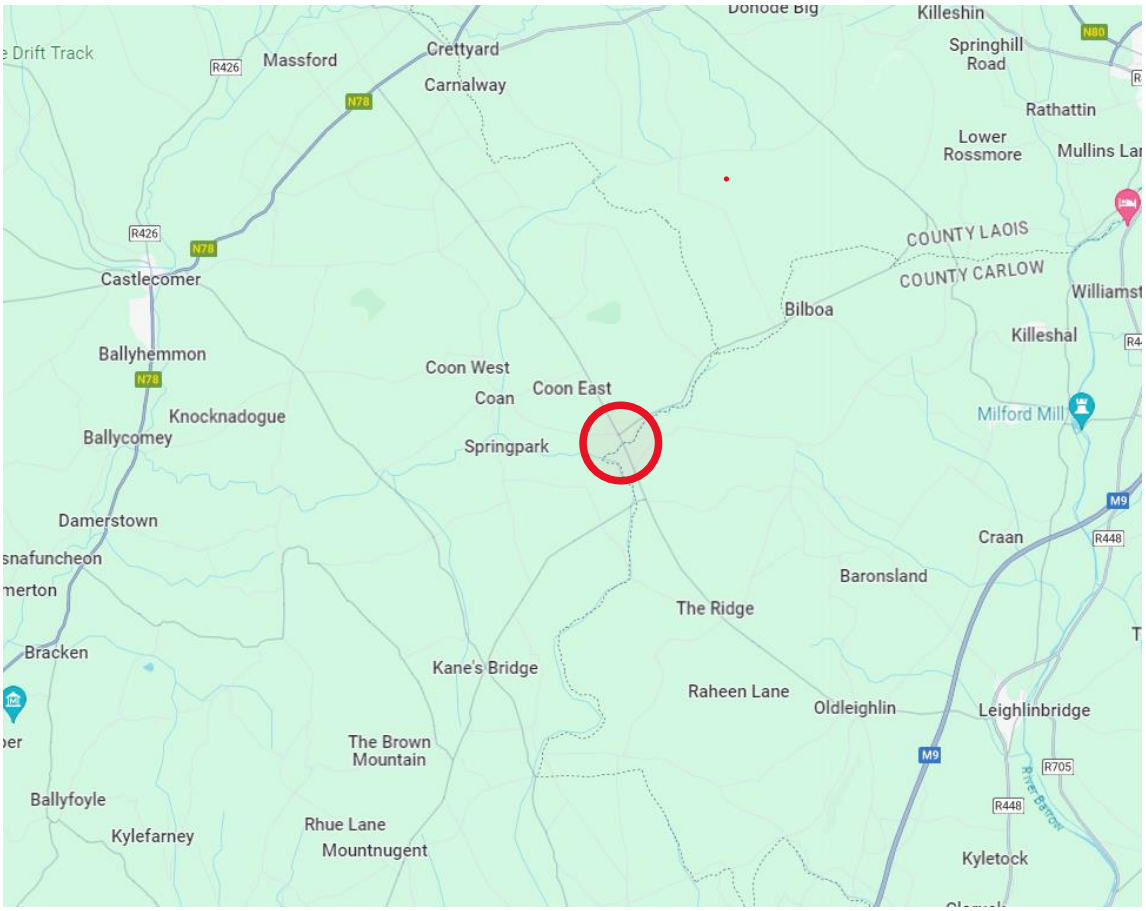


**Figure 1 – Bridge Location**

This report contains information and comments relating to the structural condition and defects present at the time of the visual inspection and an assessment of the structural integrity of the bridge. No opening up of the structures was carried out at the time of the inspection.

An assessment of the masonry arches 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.

The modified MEXE method determines the carrying capacity of masonry arches in terms of allowable axle weights. This method takes account of the materials, various defects and geometric proportions which affect the strength of the arch.



## 2 RIVER DININ BRIDGE (BLACK BRIDGE) CO. CARLOW / KILKENNY - BRIDGE DESCRIPTION

Dermot Guilfoyle of Jennings O'Donovan & Partners Limited inspected the bridge on the 24th August 2020. The bridge is a large single-span stone arch structure. The arch is 14m wide (springing level) and an arch height of 5.158m with an overall height of 8m to riverbed level. The minimum compression zone/spandrel fill is approximately 0.25m. The parapets are 500mm wide random stone masonry with average height of 1.4m above the road surface.

The undersides of the arches were found to be in relatively good condition but with some localised minor deterioration at some of the joints.

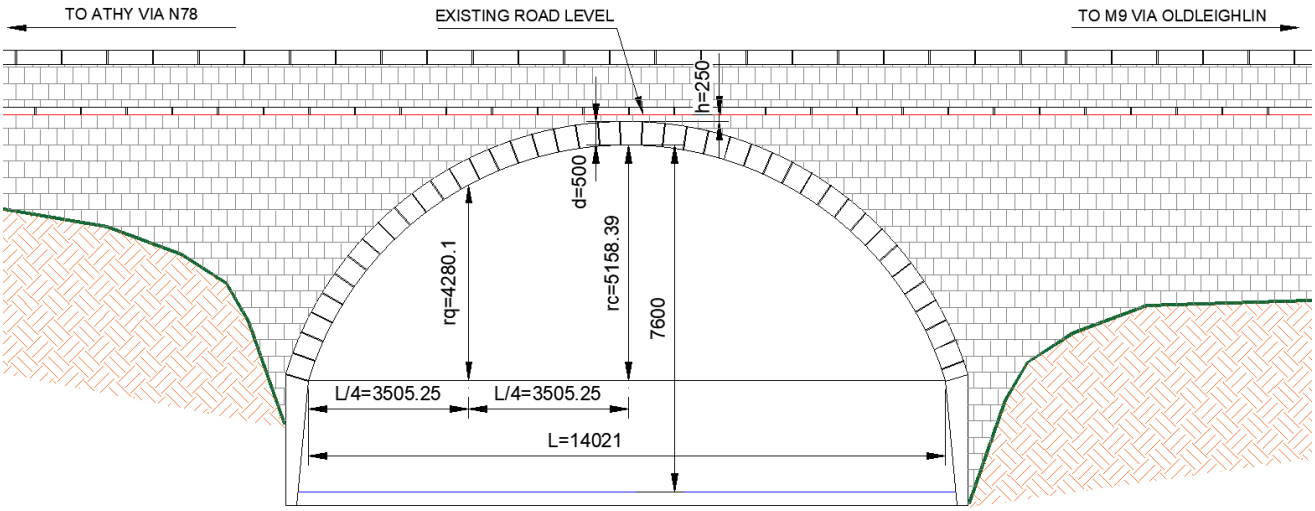


**Figure 2 – Bridge Dimensions for MEXE Method Assessment**

# 3 ASSESSMENT BY MEXE METHOD

## 3.1 Current Condition

**Arch dimensions used**

- Span $L$ = 14.021m
- Rise $r_c$ = 5.158m
- Rise at quarter points $r_q$ = 4.28m
- Thickness of arch barrel $d$ = 0.50m
- Average depth of fill, h = 0.25m

**Provisional Axle Loading (PAL)** (BA 3.10)

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

= $[740 \times (0.5+0.25)^2] / 14.021^{1.3}$ or 70 (whichever is less)

= 13.44 or 70 (whichever is less)

**PAL = 13.44 tonnes**

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

- Span/rise = 14.021 / 5.518 = 2.541
- Span/Rise Factor ($F_{sr}$) = 1.00 (as actual span / rise is less than 4 – figure 3.3)
- Profile Factor ($F_p$) = $2.3[(r_c-r_q)/r_c]^{0.6}$

  $=2.3[(5.158-4.28)/5.158]^{0.6}$

  = 0.794
- Material Factor ($F_m$) = $[(F_b \times d) + (F_f \times h)]/(d + h)$

  Where:
- Barrel Factor ($F_b$) = 1.0 (Table 3.1)
- Fill Factor ($F_f$) = 0.7 (Table 3.2)

  Therefore:
- Material Factor ($F_m$) = [(1.0 x 0.5) + (0.7 x 0.25)] / (0.5 + 0.25)

  = 0.90
- Joint Factor ($F_j$) = $F_w \times F_d \times F_{mo}$

  Where:
- Width Factor ($F_w$) = 0.9 (Table 3.3)

- Mortar Factor ($F_{mo}$) = 0.9 (Table 3.4)
- Depth Factor ($F_d$) = 0.9 (Table 3.5)



Therefore:

- Joint Factor ($F_j$) = 0.9 x 0.9 x 0.9
  = 1.0
- Condition factor ($F_{cM}$) = 0.90 (based on proven capacity and good condition)
- Axle Factors ($A_f$) = 1.0 (Figure 3.5a) (no axle lift off)

**Modified Axle Loading** = $F_{sr}$ x $F_p$ x $F_m$ x $F_j$ x $F_{cM}$ x PAL
= 1 x 0.794 x 0.90 x 0.729 x 0.9 x 13.44
**= 6.3 tonnes**

It should be noted that this carrying 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. In particular the Condition Factor of 0.9 was taken in this instance due to the overall good condition and proven existing traffic capacity.

However, despite the overall good condition for the structure, the arch is not capable of supporting the maximum axial load applied by movement of standard wind farm delivery vehicles, in its current arrangement.

In order to achieve a modified axle loading in excess of 12 tonnes, the average depth of fill above key stone would need to be increased by 200mm, thus providing an overall depth of 450mm over the span of the arch. It is intended that this would be achieved using Concrete/DBM, tapering back into the existing road level either side. See updated calculation below.

## 3.2 Proposed Increase of Fill Depth (Road Surface) by 200mm

**Arch dimensions used**

- Span $L$ = 14.021m
- Rise $r_c$ = 5.158m
- Rise at quarter points $r_q$ = 4.28m
- Thickness of arch barrel $d$ = 0.50m
- Average depth of fill, h = 0.45m

**Provisional Axle Loading (PAL)** (BA 3.10)

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

= $[740 \times (0.5+0.45)^2] / 14.021^{1.3}$ or 70 (whichever is less)

= 20.47 or 70 (whichever is less)

**PAL = 21.59 tonnes**

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

- Span/rise = 14.021 / 5.518 = 2.541
- Span/Rise Factor ($F_{sr}$) = 1.00 (as actual span / rise is less than 4 – figure 3.3)
- Profile Factor ($F_p$) = $2.3[(r_c-r_q)/r_c]^{0.6}$

  $=2.3[(5.158-4.28)/5.158]^{0.6}$

  = 0.794
- Material Factor ($F_m$) = $[(F_b \times d) + (F_f \times h)]/(d + h)$

  Where:
- Barrel Factor ($F_b$) = 1.0 (Table 3.1)
- Fill Factor ($F_f$) = 0.8 (Table 3.2)

  Therefore:
- Material Factor ($F_m$) = [(1.0 x 0.5) + (0.8 x 0.45)] / (0.5 + 0.45)

  = 0.905
- Joint Factor ($F_j$) = $F_w \times F_d \times F_{mo}$

  Where:
- Width Factor ($F_w$) = 1.0 (Table 3.3)

- Mortar Factor ($F_{mo}$) = 1.0 (Table 3.4)
- Depth Factor ($F_d$) = 1.0 (Table 3.5)

Therefore:

- Joint Factor ($F_j$) = 1.0 x 1.0 x 1.0
  = 1.0
- Condition factor ($F_{cM}$) = 0.90 (based on proven capacity and good condition)
- Axle Factors ($A_f$) = 1.0 (Figure 3.5a) (no axle lift off)

**Modified Axle Loading** = $F_{sr}$ x $F_p$ x $F_m$ x $F_j$ x $F_{cM}$ x PAL
= 1 x 0.794 x 0.905 x 1.0 x 0.8 x 21.59
**= 12.4 tonnes**