



# The Design of Strengthening and Refurbishment Works to the M4 River Usk Bridge, Wales

Tony Harris, Richard Owen

*WSP, Cardiff, United Kingdom*

Jason Hibbert

*Welsh Government, Cardiff, United Kingdom*

Contact: [tony.harris@wsp.com](mailto:tony.harris@wsp.com)

## Abstract

The M4 River Usk Bridge is a strategically vital structure that carries the TERN route M4 motorway over the River Usk to the north of Newport in South Wales and was constructed during the late 1960s. Its design incorporated modified Mesnager concrete hinges within the deck, which although considered innovative at the time, have become a significant maintenance liability. The River Usk Bridge is unique inasmuch as the hinges are concentrated at discrete locations within the four longitudinal beams that support each carriageway deck. Extensive spalling of the concrete to the beam soffits at the hinge joint locations occurred, resulting in a significant reduction in the shear capacity of the main beams at these critical sections. The strategic importance of the structure in terms of network resilience and the potential social and economic consequences of its potential closure led to the development of a unique and innovative strengthening and refurbishment solution within a fast-track, collaborative environment.

**Keywords:** strengthening; refurbishment; fast-track; collaborative; post-tensioning; concrete; thrust-hinge; motorway.

## 1 Introduction

The M4 River Usk Bridge is a 5-span twin-deck structure approximately 140m in length that crosses a tidal river designated as a Special Area of Conservation (SAC) and SSSI and the surrounding habitat is home to numerous important, protected species as illustrated in Figs 1 and 2.

The modified Mesnager concrete hinges details within the deck had been a source of concern to the structure owner, Welsh Government, since the late 1990's. Whilst there are in excess of 100 slab deck structures of this vintage around the UK motorway and trunk road network that incorporate similar hinges, the River Usk Bridge is

unique inasmuch as the hinges are concentrated at discrete locations within the four longitudinal beams that support each carriageway deck.

Long-term water leakage through the hinge throats raised concerns that corrosion to the hinge reinforcement might limit the structure's serviceable life due to its detrimental effect on fatigue endurance. This led to an extensive series of investigation and analysis over a period in excess of 10 years, at the end of which it was concluded that the structure had a fatigue life of 80 years. This meant that it would remain serviceable until the year 2047, as long as assumptions with regard to the assumed traffic