Calder Bridge Modification – M1 J39-42 Smart Motorway

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Mark studied Civil Engineering at the University of Birmingham. He has worked on the M1 J39-42 site for 9 months covering bridge strengthening, Calder Bridge modification, providing site supervision and design support. He is currently completing a bridge assessment for a 19th century swing bridge in Bristol and designing CSB installations on the M1. He also runs STEM events in local schools including Paper Tower and Bridge building.

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1. Introduction

Calder Bridge was completed and opened in October 1968 and carries the M1 over the Calder River in both directions, with three running lanes and a hard shoulder. The existing hard shoulder has an adverse camber and needs super-elevating to allow for running traffic. Its twin decks are constructed from in situ concrete units which are trapezoidal in section and have cantilevered wings extending from the sections. The decks are post-tensioned together to form a 73m central span and 18m cantilevered side spans, the side spans are connected to abutments by 6m beams to manage the potential settlement between the bridge and the abutments due to a risk of mining subsidence.

2. Content

A lightweight solution was required to retain the 45 units of HB loading needed for Calder Bridge whilst preventing overstressing of the webs and bearings. Several options were considered for super-elevating the hardshoulder on Calder Bridge, such as a steel frame or normal weight concrete but due to weight constraints and easier construction/maintenance it was decided to go with a foamed concrete wedge system, incorporating castellated lightweight concrete parapet plinths and void formers using ducting. The existing normal weight concrete plinth had to be removed using hydro demolition, and surfacing removed down the deck to allow construction to start.

Fig. 1: Calder Bridge Trial

A denser/stronger foamed concrete was located underneath the running lane, lifting up the existing hardshoulder, proposed lane 1 and verge to match the existing motorway level. A lighter/weaker foamed concrete was located in the verge and in between the castellated plinths to protect the ducting and infill the verge. Due to the non-standard shape and high workability, it was important to trial a whole section of the verge and lane 1 to see how each component would fit. The trial also provided the operatives an opportunity to work, shape and form the foamed concrete which was extremely beneficial upon construction.

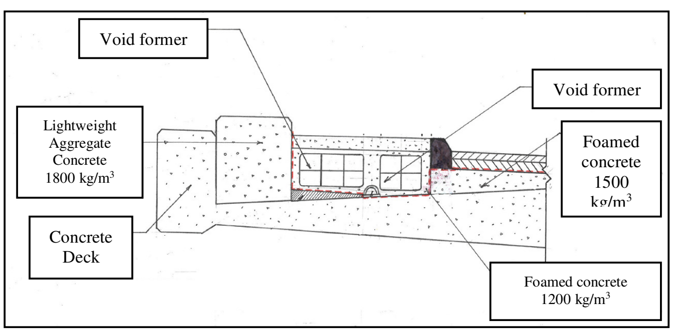

Fig. 2: Section through Calder Bridge Super-elevation

1500 kg/m^3 foamed concrete was used under the running lane, 1200 kg/m^3 foamed concrete for the verge, 1800 kg/m^3 lightweight aggregate concrete for the castellated plinths and the void formers created 0.16m^3/m of space, providing a target design weight per metre of 11.7kN/m compared to a normal weight concrete option of 22.6kN/m.

3. Conclusions

Using the foamed concrete provided an innovative solution to the issue of retrofitting super-elevation and reducing weight, which is likely to become standard on future Smart Motorways schemes. Trials and practice areas provide operatives with the skills to work with the material, and provides the client with confidence that the solution is viable and workable. Foamed concrete can be easy to work with, has lower maintenance then a steel frame verge infill option and can provide a lightweight solution to similar problems on highway schemes.