60-YEAR-OLD MOTORWAY BRIDGE REFURBISHMENT PROJECT DELIVERED

Innovative thinking and collaboration with the client and stakeholders have allowed major concrete repair works to be undertaken and a lengthy abnormal loads restriction to be lifted several months early on the River Dane Bridge in Cheshire. The motorway bridge refurbishment works were carried out by specialist contractor **Concrete Repairs Limited** (**CRL**), working on behalf of National Highways. **Jose Castro** talks about the works carried out, the issues faced and how they were overcome.

CRL is coming to the end of a £6 million structures upgrade project on the River Dane Bridge. The 85m-long viaduct was originally constructed in 1962 and carries the M6 motorway over the River Dane between junctions 18 and 19 near Holmes Chapel in Cheshire.

The bridge consists of a five-span simply supported beam and slab structure, with a longitudinal joint in the centre and with separate substructures on either side of that

joint. Each superstructure consists of 23 precast prestressed concrete 'I' beams and a precast reinforced concrete edge beam (see Figure 1).

CORROSION

During routine inspections, it was observed that de-icing salts had migrated through the bridge joints to the underlying crosshead beams, piers and columns, and penetrated through the concrete cover causing the reinforcement to corrode. This resulted in large areas of concrete spalling, which was detrimental to the long-term structural integrity of the bridge (see Figure 2). National Highways commissioned the repair works as part of its commitment to maintenance improvements to motorways and major A roads in the north-west area.

A significant challenge for CRL on this project was ensuring that the bridge remained open to vehicular traffic during the works and that the project was completed on time. Tens of thousands of road users travel on this busy stretch of the M6 daily, so keeping the structure operational was crucial to ensure minimal disruption to the travelling public.

NATIONAL HIGHWAYS

After a lengthy 18-month early contractor involvement (ECI) and negotiation process, CRL was selected as the principal contractor for the project and worked closely with National Highways to design and develop a strategy and methodology for the major repair works. Once the works were completed, the bridge would have to comply with current Standards, have a minimum design life of 50 years and again be able to carry abnormal loads. CRL first commenced work on the bridge in February 2022, using a three-phase programme that allowed the works to be carried out in a controlled manner. The third and final repair phase was completed in April 2024.

Since April 2022, the load-carrying capacity of the bridge was reduced to a maximum of 80-tonne heavy load vehicles, with this reduction due to remain in place until April 2024. However, this had a long-term knock-on effect for hauliers and companies transporting heavy goods, as trucks had to be rerouted along a lengthy diversion. However, thanks to close collaboration and the efforts of CRL and National Highways, the bridge's weight restrictions were lifted in October 2023, several months ahead of schedule.

The works across the three project phases have involved surveying and testing of the structure, removal

BELOW:
Figures 4–5 – defective areas prepared and ready to receive new repair material.

OPPOSITE PAGE, LEFT:
Figure 1 – River Dane Bridge before the scaffold installation.

OPPOSITE PAGE, MIDDLE:
Figure 2 – typical areas of defective/spalling concrete.

OPPOSITE PAGE, RIGHT:
Figure 3 – defective areas prepared and ready to receive new repair material.

ABOVE:
Figure 6 – couplers used to connect the new/replacement reinforcing to the existing.

ABOVE:
Figure 7 – the impressed current (fabric and overlay) cathodic protection system.

of all delaminated, substandard and substrength concrete and preparation of the repair areas by hydro-demolition, cleaning of the steel reinforcement (see Figures 3–5) and repairing/replacing where necessary (see Figure 6), followed by the reinstatement of the broken-out areas using Weber's Webercem Advanced Precision Grout. An impressed current cathodic protection (ICCP) system (see Figure 7) consisting of a fabric and overlay arrangement was then installed to the crossheads and columns to protect the reinforcement in the structure and provide further corrosion prevention measures.

CATHODIC PROTECTION

River Dane Bridge had been subject to previous surveys and repairs over the years, and although the earlier repairs had performed well, it was decided that the installation of a cathodic protection system was now necessary to minimise future corrosion of the reinforcement and any subsequent spalling. Not only would the system save costs but also by not having to return to the bridge to carry out future repairs, there would be no need to restrict the movement of large vehicles over the bridge.

As can be deduced from its name, the River Dane Bridge carries the M6 motorway over a river and in order to carry out the works safely, a complex bespoke temporary works system was produced for the scheme. This consisted of steel buckling straps and scaffold support steelwork, with the buckling straps clamped around the columns at the top and bottom of the repair areas. This maintained the stability of the existing structure and removed the risk of the reinforcement collapsing when the concrete was removed via hydro-demolition.

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The scaffold support steelwork comprised steel brackets, which were drilled and fixed onto the columns. A steelwork frame was then bolted onto them, thus taking the weight of the access scaffold above. This removed the need for any excavation works within the river or the motorway embankment, which would otherwise have been necessary to establish foundations for a conventional scaffold/access system. This system also had the added advantage of raising the height of the scaffold above the river water level, which avoided any potential damage during a flood event (see Figures 8 and 9).

LOCAL WILDLIFE

Environmental responsibility was a key focus throughout the project. Working on a major motorway over a river for a sustained period of time brought about several environmental challenges. Close liaison was needed with the landowner, the Environment Agency and the local fishing club

RIGHT AND FAR RIGHT:
Figures 8 and 9 – the raised and sheeted access system used to stay out of the flood range.

INSET BELOW:
Figure 10 – delamination survey and Schmidt hammer testing being carried out to the columns

to ensure that the project was undertaken and completed without any negative impact to the river and local wildlife. In order to ensure no contamination of the surrounding land or the river occurred, full water containment was implemented and monitored while hydro-demolition was being carried out. The collected water was then passed through a pH adjustment system, which reduced the pH to a suitable level, whereupon it could then be discharged onto the surrounding fields to be further filtered before working its way into the watercourse.

CARBON-SAVING

As with any construction project nowadays, reducing the project's carbon footprint to a minimum was a high priority. Notwithstanding that the repair and refurbishment of existing structures is in itself a carbon-saving measure, as opposed to constructing a new bridge, various carbon-saving measures were implemented on this project.

These included the implementation of effective waste management procedures where all timber, concrete and packaging waste, which totalled 98.99% of all the site waste, was diverted from landfill (thus saving 121 tonnes of CO_2e in the process), the use of HVO (hydrotreated vegetable oil) fuel to power construction plant machinery and using Eco Welfare Cabins on-site.

The project team actively engaged with the local communities supporting various initiatives, as well as hosting a site tour for 30 engineering students from Liverpool John Moores University (which led to a six-week placement opportunity for one of the attendees as a student engineer with CRL). National Highways and CRL also partnered with the Environment Agency, the local fishing club and the Friends of the Dane Meadow volunteer group to manage the upkeep of the Dane Meadow nature reserve.

REPAIR WORKS

This was a challenging project carried out over water and on a 'live' bridge, with ECI being key to its success. Through the use of innovative engineering solutions and by undertaking the repair works in a carefully planned and executed manner, CRL was able to deliver both cost and programme savings, resulting in the successful delivery of this scheme on behalf of National Highways.

Mangat Bansal, programme delivery manager at National Highways, had this to say, "The team's unwavering dedication to undertaking works safely and the quality of the repairs were nothing short of outstanding. Road safety was also always at the forefront of their role, but they also ensured that local communities were actively involved, every step of the way."

PROJECT OF THE YEAR

The innovative nature of the scheme has already been recognised, with it receiving the coveted 'Project of the Year' title at the National Concrete Repair Association (CRA) Awards hosted in Liverpool in October 2023, as well as the CRA 'Repair & Refurbishment Award' presented at The Concrete Society Awards in London in November 2023. C