Redbridge Viaduct

Steve Jones of Concrete Repairs Ltd (CRL) looks at current repair works undertaken to Redbridge Viaduct in southern England.

The Redbridge Viaduct is part of the A35 Redbridge Causeway, which links Totton to Southampton and the M271. Issues with the structure were identified during routine bridge inspections and comprehensive testing, inspection and assessment were subsequently undertaken. These investigations showed that the viaduct structure had some support elements rated as very poor. Unless significant repairs were carried out, traffic restrictions would have needed to be implemented on this important transport route. Replacement options were rejected, given the cost, environmental considerations, unexploded ordnance risks and the associated road disruption, in favour of repairing and installing an impressed current cathodic protection (ICCP) system. The Redbridge Viaduct project is the second phase of three projects that will be necessary to complete the refurbishment of the Redbridge causeway.

The southern viaduct structure consists of seven leaf piers, ten column beam bents and two cantilever cross-head piers. Of these, five leaf piers and eight of the bents are in the tidal estuary, which is a Site of Special Scientific Interest and nature reserve. Two leaf pier structures sit either side of the railway line that passes beneath the A35 and are included within the next phase of the project.

As Hampshire County Council's term service provider, Skanska Infrastructure undertook a tendering process to appoint a specialist contractor to engage in an ECI process for the refurbishment of the viaduct. Concrete Repairs Ltd was appointed to develop the scheme in conjunction with Hampshire County Council and Skanska, and their designer Atkins.

The collaborative ECI process between the parties developed the main aspects that have been critical to the smooth running of the project, as follows:

- Overall risk workshop with all stakeholder parties to consider potential project risks from many different perspectives.
- Development of methodologies around the access and hydro-demolition works to enable the marine management operating license to be granted.
- Removal of any propping in favour of a sequential approach to the repairs, which required up to 20 phases of repairs on some bents. Propping without any suitable foundations would have been hugely problematic logistically and environmentally, as well as very expensive.
- Development of the site logistics and general movement around site. The main works are separated from the route onto

Above: View of causeway leaf piers 17 and 18 scaffolded, with further bents scaffolded.

Scaffolded column bent at low tide.

CRL breaking out repairs on bent.

site and the welfare compound by the side of the A35, so access scaffold bridges needed to be set up to allow movement of personnel and materials around openings by piers eight and 16 that were then linked by a scaffold over the ground ridge that ran between the pier bents. Safety boats manage the waterways from pontoons located in the estuary.

- Removal of the need for any coffer dams by consideration of tidal programmes and work sequences.
- Development of access scaffolds with RBS Scaffolding that enabled the leaf piers to be accessed and for entrapment of the wastewater to be possible over three lifts of scaffold. The scaffolds on the leaf piers had to be suspended off the piers using shear plates bolted onto them. Cantilever scaffold access also needed to be developed for the installation of the multi-core cables and junction boxes for the CP system.
- Design to bring the identified dowels into the CP system with a series of continuity bonds.

Following delay due to the lockdown in March 2020, the team agreed new protocols and procedures to be adopted on-site, including one-way systems, regular cleaning and additional welfare facilities, which enabled works to resume in late May.

The column beam bents were accessed using independent scaffolds founded on the ground. The works needed to be very carefully undertaken following the detailed repair sequence produced by Atkins. CRL undertook the breaking out with hand-breakers and repaired using hand-placed repair mortar, working around tides. Some minor excavation was necessary around the pairs of bents, progressed in line with the designed sequences. The ICCP system chosen for these bents consists of discrete mixed metal oxide (MMO) tubular anode placed in pre-drilled holes to avoid steel reinforcement.

Leaf piers

The leaf piers have been very challenging to repair, given the tides and constraints of the environmental permit for the works. RBS Scaffolding used shear-plate fixings and drilled bolts to support the three lift scaffolds around the leaf piers. With significant volumes of repairs required on the leaf piers, as well as full surface preparation necessary for the ICCP system, CRL chose the method of hydro-demolition. But this meant that the water run-off from the hydro-demolition needed to be trapped, channelled to a sump, and then pumped to a Siltbuster water treatment unit and a further filter unit, to adjust the pH and reduce solids to acceptable levels before discharge into the river as part of the MMO environmental discharge license.

CP mesh overlay on leaf pier.

On a number of leaf piers affected by the worst tidal interactions, extensive steel reinforcement was replaced in the concrete repair areas due to at least 20% loss of original reinforcement cross-section caused by corrosion, even though there was good concrete cover at 90mm thick.

CRL sprayed back the repairs on the leaf piers using Fosroc's Renderoc DS rapid-setting dry spray in tidal areas. This achieved an early set within an hour, which was necessary given the short tidal window available on the lower lifts. Works on the leaf piers required up to three phases of repairs, with some of them requiring up to $3m^3$ of material.

Breaking out on pier 18 revealed a lack of reinforcement at the top of it. Atkins designed a detail for new corbels to be incorporated into the pier, with CRL undertaking the works on a hit–miss basis.

A Monro spinning head jet was used to create a rough profile on the leaf piers for the bonding of the ICCP overlay system. Half-cell surveys were undertaken to determine the position of the reference electrodes. CRL undertook continuity checks across the structure to check the reinforcement was continuous. The dowels identified at the top of the piers were linked together and bonded to the reinforcement.

CRL then installed the MMO titanium anode mesh to the face of the piers using plastic fixings. The mesh was welded to the primary anode that was joined to the positive feed cable, which ran back to the junction box at the top of the piers. Six negative connections, plus a further four test negatives were welded to reinforcing bar to form the negative circuit and again taken to the junction box.

The overlay 25/30mm of Renderoc DS dry spray was sprayed over the installation, again using rapid-set for the tidal areas, following sign-off of the installation and saturation of the substrate. Multi-core cables join the junction boxes together and these run the length of the viaduct back to the TR boxes, which have been established either end of the viaduct.

The works are progressing well, with the completion programmed to be ahead of the original 69-week period towards the end of the summer 2021. The project is a testament to the collaborative input of all stakeholders involved who have worked together to overcome a series of difficult construction and environmental problems to refurbish the Redbridge Viaduct for many years to come.

The follow-on phase-three works have had ECI collaborative input from CRL to assist in the design and co-ordination of works on the north bridges and over the railway lines. ■

Leaf pier seven scaffolded with other bents scaffolded further up.