

Nature proves no inhibitor to concrete bridge repair

Bats, periods of prolonged persistent rainfall and fluctuating river levels were just some of the obstacles faced during the refurbishment of Clifton Bridge in York – a process that used traditional and innovative repair techniques.

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Clifton Bridge is a six-span structure, each span comprising 22 prestressed, precast, Dow Mac beams spanning 16.5m and supported on in-situ reinforced concrete piers, abutments and wingwalls. The bridge was opened in 1964 and carries the two-lane principal road (Water End) over the River Ouse, a navigable waterway, and provides a clearance of 7.3m above mean summer level of the river.

Following an inspection of the bridge, the city engineers, supported by a specialist concrete testing survey (including subsurface half-cell testing and rate of corrosion calculations), decided that the optimum time to commission refurbishment works to the bridge had been reached. The works would address the problems of chloride contamination, spalling concrete and the tired anti-carbonation coating, with the aim of prolonging the effective life of the structure. Following a competitive tendering process Topbond was appointed to undertake the works, which were carried out by its northern division, based in North Lincolnshire.

The existing coating system had to be removed to allow a full inspection of the concrete. Topbond trialled a number of systems, including steam cleaning, dry-ice blasting as well as wet and dry blasting. The team opted for a combination of dry blasting over the land spans and the DOFF pressurised superheated steam system over the river spans. Containment measures were taken to collect the removed coating and spent media and prevent contamination of the river.

Following removal of the coating a delamination survey was undertaken. Delaminated areas were generally small and removed by percussive means. However, during the survey

significant areas of hollow-sounding concrete were found in the river piers. In these areas concrete removal was undertaken using high-pressure water jetting and then, after grit-blasting, the concrete was reinstated using approximately 10 tonnes of SikaCem 133 Gunite.

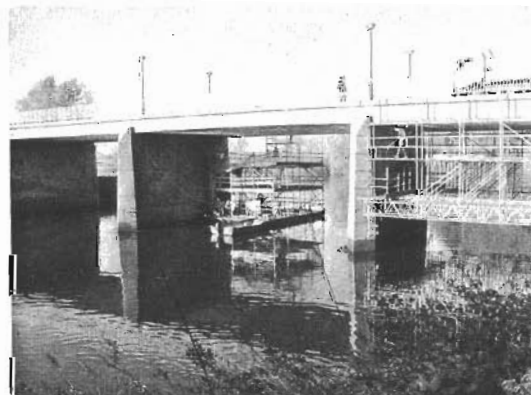
To protect the steel reinforcement in the precast and in-situ elements of the bridge, the client wanted the further protection offered by migrating corrosion inhibitors. As an approved installer of QED's system, Topbond installed approximately 5000 Margel DCI 580T microporous cartridges containing the blended components of migrating vapour phased corrosion inhibitors (MVPCIs or VPIs for short) offering fast medium- and long-term protection. Each cartridge was installed in a 20mm-diameter hole at a depth of 100mm below the concrete surface, covered with a compressible disk and then sealed in place with a repair mortar. This has the advantage of placing the material at the depth of reinforcement, allowing the cartridges to offer immediate protection to the steel reinforcement. The Clifton Bridge contract is to-date the largest bridge refurbishment contract to use QED's Margel cartridges.

The application of more than 1000 litres of Sikagard 550W solvent-free anti-carbonation coating in two colours not only improved the appearance of the structure but also offered high-diffusion resistance against carbon dioxide, reducing the rate of carbonation.

The existing parapets were upgraded to offer improved vehicle impact resistance and their height was raised to allow the pavement to be used by cyclists. The existing paving slabs were removed, patch repairs to the deck waterproofing were undertaken and the footpath resurfaced with tarmacadam. The removal of the old lighting columns from the edge of the footpath opened it up to future use by cyclists.

At the south end of the bridge, two concrete pilasters were suffering from rotational settlement and partially sinking into the earth-filled approach ramp. Topbond's initial plan was to underpin the pilaster using AB Chance screw piles but this proved impossible due to the presence of an unseen obstruction, which was hit 3m below ground level. One of the advantages of the AB Chance screw piles is that they can be easily withdrawn, resulting in minimal disturbance to the ground, which allowed Topbond to lift the pilasters and reposition them onto the adjacent piled wingwalls.

Figures 1 and 2:
The pontoons used for repair work on the RC piers.



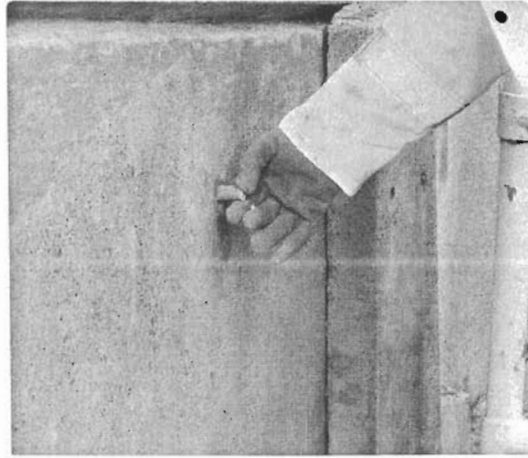


Figure 3 far left: Reviewing the concrete removed by water jetting.

Figure 4 left: Installation of the Margel cartridge system.

As the bridge was a known roosting area for bats, expert advice was sought from English Nature and the council's in-house experts and the site monitored. To protect this environmentally sensitive area, the start date was partially delayed in four of the six spans until the end of the breeding season.

To gain access to the structure, Topbond used birdcage scaffolding over the land spans and beamed over the riverbank spans taking support off the piers. For the river span, birdcage scaffolding – with cantilevered walkways along the side giving access to the piers – was built off Topbond's floating steel pontoon. Warning signs were installed upstream and downstream of the bridge to advise the river users of the work and Topbond was in close contact with the operator of local river sightseeing cruisers.

Due to the exceptional wet weather during the autumn of 2008 the river was prone to swift and significant changes

in level. In the worst case a change in level of approximately 4m took place over one 48-hour period, leading to flooding of the surrounding land. This heavy rain and flooding brought with it considerable river debris and this, together with the wind-loading on the sheeted scaffolding, kept the skipper of Topbond's safety boat busy.

The site team also had to deal with the restrictions imposed by a confined site, located in an urban area and carrying a busy commuter route over the bridge. To overcome this, Topbond had to carefully monitor and modify its proposed working techniques and material selection, evolving them on-site as required. A prime example was the just-in-time delivery system developed by the company and its material distributor (EPMS of Leeds) to ensure the site was regularly supplied with an adequate quantity of material using small- to medium-size delivery vehicles.



Figure 5: Application of sprayed concrete.