Silver Jubilee Bridge

A 25 Year Repair Strategy

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Silver Jubilee Bridge

- Constructed in 1961
- Designed to pre & post WW II British Standards
- Widened in 1977
- Granted Grade II listed status in 1988

Silver Jubilee Bridge

- Steel arch main span, 330m long
- Approach spans are 522m in length
- Approach viaducts have pre-cast beam ends, otherwise cast in-situ
- Widening in late 1970’s employed encapsulated piers with post-tensioned crossheads
- Originally called the Runcorn Widnes Bridge, it was renamed the Silver Jubilee Bridge in 1977

English Heritage Grade II

- "Structures, predominantly buildings, are usually listed because of age, rarity, architectural merit and method of construction"
- A Grade II structure is of "special interest, warranting every effort to preserve it"
- Restrictions: “Listed buildings may not be demolished, extended or altered without special permission from the local planning authority”
  - Including the colour of the paintwork
Problems

- After 25 years in operation, the majority of problems associated with the structure were due to chloride induced corrosion of concrete reinforcement
- The bridge had been completed 2 years prior to the introduction of chloride-based de-icers in the UK
- The first areas to suffer were the approach viaduct supports where every third pier was located beneath a joint
- A further problem was that the main deck had not been waterproofed (unusual for UK) and despite high quality mastic asphalt surfacing, chlorides from de-icing salts had penetrated the concrete

Initial Investigations

Corrosion Prevention

- Holding repairs with inhibitors
- Corrosion inhibitors
- Small patch repairs
- Cathodic protection (CP)
  - Impressed current systems
    - Mesh & overlay, discrete anode
    - Dry and wet spray overlays
  - Galvanic systems
    - Discrete anode, zinc hydrogel sheet
- Electro-osmosis
Holding Repairs, 1992

- Public safety concerns
- Patch repair
  - Polymer modified cementitious mortar
  - Incorporating corrosion inhibitor to avoid 'ring anode' formation
- After 10+ years had prevented significant section loss and further spalling

Cathodic Protection, 1993 Onwards

- 1993
  - First contract awarded
- Innovations
  - Hydro-demolition
  - MMO titanium mesh and dry sprayed concrete with steel trowel finish
- Next two contracts used same system

Repair Performance

- Condition after 30 years service
- Appearance 20 years after repair with CP
Overlay Delamination

- Initial concerns over delamination from trowelling were overcome by careful QA and testing.
- Only major overlay problem encountered with wet spray was used on application adjacent to school.
- Widescale delamination occurred, apparently due to desiccation at the interface.
- Co-operation between client, consultant, contractor and material manufacturer resulted in a cost-effective solution.
- Overcoated with a PMC mortar reinforced with a two-way e-glass scrim.

- Has proved very durable (>15 years) with no worsening of delamination and the CP continuing to operate normally.

Encapsulated Piers

- Encapsulating concrete later found to have AAR
- Fibreboard retained water, worsening problem
- Problem resolved by either electro-osmosis or galvanic CP plus reinforced PMC coating

Encapsulated Piers – Electro-Osmosis

Encapsulated Piers – Galvanic CP
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• Approach viaducts and piers relatively straightforward to repair – access from ground level
• Deck provides restrictions
  • Major highway link
  • 90,000 vehicles per day
  • Closure results in 65km diversion
  • Partial closure results in heavy congestion
  • 40m above River Mersey
  • Plus the Grade II restrictions

CP of Main Suspended Deck

Surface Mounted Cassette System

- Cross sectional schematic of the ‘Cassette’ system

- Glass fibre pad impregnated with calcium nitrate
- Stainless steel bolt @ 500mm c/c
- Mixed Metal Oxide Coated
- Titanium Ribbon Anode
- GRP casing

Surface Mounted Cassette System
Pre-Cast Pre-Stressed Beams

- Used in widening
- Elements have generally been in better condition
  - High strength/high quality concrete
  - Not as old as in-situ concrete
- Starting to show signs of chloride induced corrosion
- Conventional repair methods are, for the most part, not applicable
- CP has only rarely been considered for pre-stressed concrete elements
- Concern over possible risk of Hydrogen Embrittlement

Pre-Cast Pre-Stressed Beams

- Electrical continuity of steel
  - Welding or shot firing not feasible
  - Achieved using metal straps, cable ties and tie wires
- Breakouts
  - Assessment of extent of corrosion
  - Hydrodemolition
  - Residual stress in elements / loss of bond
- Anode system
  - Zinc hydrogel sheet anode, overcoated to camouflage and prevent self-corrosion
- Monitoring
  - From 7 days before installation onwards
  - In operation since August 2011

Pre-Cast Pre-Stressed Beams – Galvanic CP
Other Works

- Maintenance of Protective Coating
  - Historically used lead-based primers and metal spray
  - Now use water based and low solvent formulations with glass flake fillers
  - 5% treated each year therefore a continuous job
  - Change of colour not possible

Other Works – Coatings

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  - Buried, rail and mechanical

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- Cable Wrapping
  - Preferable to coating as could be carried out without closing bridge

Other Works – Cable Wrapping

- Parapet Upgrade
  - Original parapets not capable of resisting modern heavy goods vehicle impact

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The Future of SJB

- There remains an on-going requirement to maintain the bridge
  - CP – now fully integrated into a single monitoring and control system
  - Protective coatings – continuing requirement
- New second road crossing – Mersey Gateway
  - Due to be completed in 2017