Baitings Gate Bridge Refurbishment

preservation of an asset to provide a low-maintenance safe crossing of the reservoir for the public

by Paul Bennett PhD MEng

Baitings Gate Bridge crosses the upstream end of Baitings Impounding Reservoir (IRE) near Ripponden, West Yorkshire. Baitings IRE is approximately 1km long and has an average width of 300m. The volume of the reservoir is approximately 3,523,000m^3 and the top water level (TWL) is 257.560m AOD. The reservoir is the upstream in a cascade of two, with Ryburn Reservoir located downstream. Flows enter the upstream end of Baitings IRE from the River Ryburn (and Horse Hay Clough & Clay Clough side streams). The reservoir, bridge and surrounding land are owned and operated by Yorkshire Water Services (YWS).

Placing of the new bridge beams utilising the floating barge to accommodate the 90T crawler crane - Courtesy of Mott MacDonald Bentley Ltd

Requirements

In-line with the recommendations of a report undertaken by consultant OVIC Ltd, the brief for the project included:

- Removal of the existing bridge deck structure.
- Refurbishment of the pier heads where required.
- Construction of a new deck and bearings, designed and constructed to modern bridge standards.

The project was awarded to design and build contractor Mott MacDonald Bentley Ltd (MMB), with a project value of approximately £1.9m. The project gave MMB the opportunity to marry their knowledge of IRE sites with their highways and bridge experience.

Investigation

Construction of the original bridge was completed in 1956 by Wakefield Corporation Water Works. The existing bridge was formed of reinforced concrete piers carrying precast post tensioned beams, with the beams carrying the reinforced concrete deck. The bridge has a total length of 105.5m between abutments, comprising of 7 (No.) spans. The approaches to the bridge are 16 (No.) beams wide, with the middle spans being 10 (No.) beams wide.

In March 2013, Calderdale Highways Department required closure of the bridge until a formal assessment of the condition could be undertaken and a load capacity assessment made.

A full inspection of the bridge was subsequently undertaken by OVIC Ltd in 2013 and the results presented in their August 2013 Principle Inspection Report. Early consultation and involvement of Calderdale Council showed the proposed work to be covered under permitted development rights.

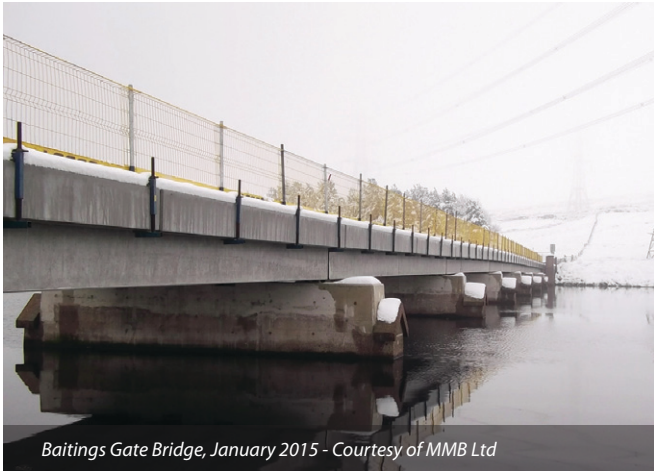
Project challenges

Operational constraints on water level (0 to 2m below top water level) led the team to propose a barge and crane arrangement (both in demolition and construction). MMB worked closely with YWS to maintain the level in the reservoir both for operation and construction.

Floating pontoons with edge protection for safe access
Courtesy of Mott MacDonald Bentley Ltd


Placement of pre-stressed concrete beams - Courtesy of MMB Ltd


Hydro-demolition environmental protection - Courtesy of MMB Ltd


Baitings Gate Bridge, January 2015 - Courtesy of MMB Ltd

During the project the existing piers (to be retained) were left exposed, without a bridge deck. This was only possible due to MMB undertaking detailed calculations at tender stage to prove they were stable enough without the deck. This removed the requirement for a costly propping structure during the demolition phase.

It was essential during this time that the barge did not impact the piers and affect their structural integrity. A series of winches, spud-leg piles and detailed risk assessments and method statements were utilised to prevent any collisions during this period of work. To ensure the stability of the retained piers, MMB implemented a *green-amber-red* alert system for monitoring deflection of the piers during removal of the beams (and landing). If deflection rose above 20mm, work would be stopped and an Engineer would visit site to assess the piers.

The water level also ruled out the possibility of using scaffolding during the pier refurbishment. Alternatively, a series of floating pontoons with edge protection were used to provide a safe working platform with workers wearing life jackets.

Using a crane on floating pontoons also presented new challenges as the largest crane that could safely be supported by the barge was only just within radius for the heavy beam lifts. Overhead power lines on the west side of the bridge restricted the crane to only work on the opposite side. Therefore, detailed planning of the lift sequence, barge position and amount of ballast required to trim the barge was required for all 117 (No.) beam lifts.

MMB worked in close collaboration with specialist precast concrete supplier Banaghers to utilise TY and TYE pre-stressed concrete bridge beams, providing large savings in terms of material and, therefore, embodied carbon.

Working above a raw water impounding reservoir has its own challenges, namely preventing pollution of the reservoir from demolition/construction material. A pontoon with porous meshing was used beneath the bridge deck during coring, saw cutting and removing the existing beams to catch and contain any potential debris, preventing it from entering the water.

An initial Ecology Report (undertaken by ARUP) indicated the potential presence of roosting bats in the underside of the bridge spans. As a consequence, MMB conducted a full dusk/dawn survey prior to starting on site. This confirmed that no bats were present. As a mitigation measure a bespoke Environmental Management Plan was produced and briefed to the site team. In addition, due to the proximity of the site to the South Pennines Moor SSSI (Site of Special Scientific Interest), SPA (Special Protection Area) and SAC (Special Area of Conservation), consultations were undertaken with Natural England to minimise, as far as possible, any impact from the site.

Engineering solutions

Hydro-demolition was used to remove the existing concrete from the pier tops in order for them to be repaired and re-cast. During hydro-demolition the piers were surrounded by netting to prevent debris entering the reservoir. Following hydro-demolition it was found that the existing pier reinforcement had suffered from chloride attack. Sacrificial anodes were cast in situ to protect both the new and existing reinforcement.

During construction, concurrent programming of beam removal and hydro-demolition has allowed the project to meet programme deadlines. The deck width was also challenged which allowed for one beam per span to be removed. It was concluded that narrowing the carriageway resulted in a safer overall design as it removed the possibility of vehicles trying to pass on the bridge (of which there was prior evidence).

There was a need at Baitings Bridge to ensure relatively straightforward maintenance of the bridge structure and bearings. This was achieved by modifying the design to provide two bearings per bridge beam rather than the more traditional one. This allows the bridge deck to be jacked-up for bearings to be replaced as and when necessary. Another benefit of this part of the design is that it removes the need for a complete set of concrete diaphragms between the beams themselves as these would originally be used as jacking points.

The new bridge deck was designed using Building Information Modelling (BIM) in order to prevent clashes on-site with the precast elements to be used.

This was vitally important as, unusually, the string course and edge beams would not be provided as a single piece as this would prove too heavy to lift using the crane/barge arrangement. Instead a 'box beam' was provided to ensure stability of the string course beams during their temporary state (before the bridge deck was cast). Visualisations (as part of the site team's morning briefings) were used to help with understanding the design and sequencing of the project.

MMB operate a close Core Team working arrangement with YWS whereby key personal involved with the project meet monthly (on site) to discuss design and construction issues and to agree how best to proceed. As YWS are unfamiliar with bridge structures, ARUP was appointed to act as technical advisor and attended all Core Team meetings.

Close working between the interested parties allowed for fast approval of decisions removing any impact on the construction programme. MMB also held regular 'Director Interventions' (reserved for high value projects) in order to challenge aspects of the design/delivery at regular intervals.

Stakeholder engagement

Every effort has been made to limit the impact of the works on the local community by providing diversions (road and footpath) for local residents. This also included providing information boards on-site as well as information on the Calderdale Council website. Letters were sent to local stakeholders keeping them informed at all stages, and the local Councillors and MP were engaged with in collaboration with Yorkshire Water's Public Affairs team.

The site was also on the route of the prestigious Tour de France 2014 which passed by the site entrance without issue. The site team were photographed with the Tour Directors' helicopter, which landed in close proximity to the site while the riders sped past.

Conclusion

The Baitings Gate Bridge project has provided significant engineering challenges throughout the design and construction phases, dictated by significant site constraints and working above an operational, raw water asset.

By adopting a collaborative approach, MMB working with YWS and the supply chain, as well as other third parties, has overcome these challenges to preserve an asset that provides a low-maintenance safe crossing of the reservoir for the public.

Due to the location of the site, the site team was forced to contend with harsh weather, including extremely high winds, cold temperatures and snow. Despite this, the project is on programme and budget and is due for completion in June 2015.

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