

Panel for Historical Engineering Works Newsletter

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The Historic Bridge and Infrastructure Awards 2014 by David Greenfield

David Balmforth, President of the ICE, presented one Award and one Commendation at the 17th annual awards ceremony on 19 March 2015. Both projects involved iron bridges, and in a change from our usual format, the two successful teams gave technical presentations to an invited audience, followed by a question-and-answer session.

Grateful thanks are again due to the following for their continuing support:

- English Heritage
- Network Rail
- River & Canal Trust
- ADEPT Bridges Group
- *New Civil Engineer*
- ICE PHEW

AWARD – River Nene Underbridge refurbishment project



The two Up-tracks (southbound) of the East Coast Mainline are carried over the river Nene from the south of Peterborough Station by a cast-iron bridge, which was completed in 1850 to the design of Joseph Cubitt. It is now the only cast-iron bridge in Britain that still carries unrestricted high-speed mainline railway traffic, and is Listed Grade II*.

Each of its three heavily skewed spans has six arch ribs, spanning 19m; the ribs are in two sections, bolted together at the crown. Cast-iron lattice spandrel-panels support cast-iron deck plates and the ballasted track. The four inner arch ribs effectively carry the tracks, the outer ribs being less heavily loaded. The ribs meet at skewbacks at the intermediate piers with each skewback supported by two fluted columns, which are supported on concrete-filled cast-iron caissons. Over the years, the spandrels had been extensively plated and repaired, and additional transverse and plan bracing has been added.

The observed condition and structural behaviour of the bridge appeared to contradict its theoretical under-capacity by a significant margin. During the tender phase of the strengthening and refurbishment project, Bam Nuttall and Aecom, their preferred designer for the project, contended that additional modelling and detailed structural inspections were likely to demonstrate that major changes and additions were unnecessary. Following completion of a draft design and associated pricing of the works, Network Rail appointed Bam Nuttall as principal contractor who instructed Aecom and Taziker International Engineering to progress the works accordingly.

Detailed inspection revealed that some of the apparent tensile fractures in the ironwork were in fact merely minor casting faults; added confidence was provided by subsequent analysis that concluded that these areas were in fact in compression. The inspection also highlighted the causes of other problems, such as the water leakage through the deck plates which was the cause of most of the defects.

A dynamic analysis enabled the enhancement factor to be determined less conservatively than previous hand calculations, resulting in less onerous load effects and lower stress levels. Crucially the theoretical stresses in the arch ribs and spandrel elements were now deemed to be within required limits.

The key aspects of the maintenance works that were identified included over-plating fractures in the spandrels, filling the seating gaps between the spandrels and the arch rib top flanges to provide even bedding and support, replacing corroded crown bolts, and sealing deck joints by injection techniques from the underside.

Judges' comments: Innovative design and sensitive execution successfully repaired and restored the oldest cast-iron bridge in the UK that still carries high-speed

mainline railway traffic. Exemplary refurbishment of a piece of crucial 'working heritage' infrastructure.

COMMENDATION – Crook O'Lune East Viaduct restoration project



Two wrought-iron viaducts, built in 1880, carried the Midland Railway (formerly the 'Little North Western Railway') over a U-shaped bend in the River Lune north of Lancaster. The route is now a busy cycleway, used by walkers, cyclists, horse riders and large numbers of recreational visitors.

Both viaducts are Listed Grade II, and are of essentially similar construction. Four rows of wrought-iron arch ribs, spanning 14m between masonry abutments and piers, carry a timber deck and wrought-iron parapets; the west viaduct has six spans, the east has five. The West Viaduct was restored in 2005, but financial constraints caused Lancashire County Council to postpone work on the East Viaduct. Continuing deterioration of the timber deck resulted in its closure in 2011, and the following year the deck and parapets were removed as a safety precaution.

Experience gained during the previous scheme was used to inform decisions about the restoration of the East Viaduct. Instead of making major adaptations the philosophy adopted was to review the previous scheme and make incremental changes to the methods and procedures previously used on the basis of 'lessons learned' to achieve an overall improvement economically.

The main works entailed complete replacement of the timber decking, and blast-cleaning and repainting the ironwork. The most significant change to the previous design was the specification for the 100+ tonnes of hardwood timber beams. The original beams had been pressure treated Douglas Fir and many of the preservatives used at the time are now prohibited. The West Viaduct had specified a choice of two legally-sourced tropical hardwoods for the replacement deck. However, since then the availability of Forest Stewardship Council (FSC) certified hardwood timber had greatly improved, and the East Viaduct specification now required all timber incorporated into the Works to be FSC certified. Also, the performance qualities of the timber

were specified, rather than specifying the species of timber. This was done to help reduce the reliance of the construction industry on a limited number of species, thus encouraging biodiversity. In another change, the required durability of the deck planks was related to their exposure condition instead of using the same timber throughout the entire deck; some deck planks are protected by impervious anti-skid panels and therefore not as exposed as the outer beams. This allowed the use of European Oak and greatly reduced the amount of tropical hardwood used by the previous scheme.

Another minor change was in the specification for fixing the deck planks. The new specification prohibited the use of threaded dowels, and instead required screws to provide a better fixing and assist future maintenance. Although this change resulted in additional work to countersink the 4000+ screws, it was welcomed by main contractor Casey, as it greatly reduced the risk of hand arm vibration when compared with installing dowels.

Judges' comments: Sympathetic restoration has transferred a near-derelict liability into an attractive, community-friendly asset. A successful combination of traditional techniques and skilfully selected modern materials.

The full list of nominated projects:

- Jubilee Bridge refurbishment, Appin, Argyll & Bute
- Crook O'Lune East Viaduct restoration, Lancaster
- Chantry Bridge repair, Wakefield
- Ballochmyle Viaduct strengthening, Ayrshire
- River Nene Underbridge refurbishment, Peterborough
- King's Road Arches reconstruction, Brighton
- Hertsfield Bridge refurbishment, Kent
- Two Tunnels Greenway, Bath and North East Somerset

The Forth Bridge's Original Riveter by ICE Scotland



Professor Paul Jowitt and Professor Roland Paxton

An original Victorian hydraulic riveting machine which was used on the Forth Bridge was unveiled at the Institution of Civil Engineers' Scotland Museum at Heriot-Watt University on Friday 27 March.

The 'portable' riveter, which weighs a quarter of a tonne and is thought to date from around 1887, has been generously loaned by York's National Railway Museum and specially transported to Edinburgh for display starting in the month of the 125th anniversary of the opening of the Forth Bridge.

Professor Paul W Jowitt CBE, former ICE President and past Chair of ICE Scotland, unveiled the riveter. He said: "The riveter makes for an iconic display, providing an instructive and exclusive insight into the extraordinary achievement of the construction of the world's greatest bridge in 1890."

Professor Roland Paxton, Chairman of ICE Scotland Museum, added: "This magnificent structure was all the more remarkable when one considers that the execution of the Forth Bridge was by means of labour-intensive Victorian technology before the development of electricity, welding and other improvements in engineering and production techniques."

Invented by William Arrol & Company, the riveter is believed to have been employed at the bridge using water-power – with the remarkable pressure of 3 tons per square inch – to squeeze into place at 'yellow heat' some of its 6,500,000 rivets.

This finely restored example, now on public display, may be the only surviving riveter of this model.

The riveter display, with an explanatory broadsheet, was fabricated at the workshop of the University's School of Energy, Geoscience, Infrastructure and Society.

Members of the public are welcome at the Museum during normal working hours.

Further information can be found at http://web.sbe.hw.ac.uk/ICE_Museum/index.htm

Dunston Staiths Re-opens to the Public

by Tony Henderson



Dunston Staiths, 1970s © Sirkka Liisa Konttinen

As reported in the *Newcastle Chronicle* on 24 March: A monument to Tyneside's industrial past has begun a new life as the river's latest visitor attraction. People will now be able to walk along part of Dunston Staiths (HEW 2003) on the Gateshead riverside to take in the spectacular views of the Tyne and its bridges. It follows the completion of restoration work on forty of the structure's ninety-eight timber frames, which were damaged in arson attacks.

The launch event at the staiths marked the opening of the 'summer season' which will see the structure opened to visitors on Wednesdays and one day – to be decided – at weekends. There will also be a programme of events and guided tours with details to be announced on www.dunstonstaiths.org. Visitors will be able to take a 400-metre circular walk, using the upper and lower decks of the structure.

The repair operation to the staiths cost £470,000 with owners Tyne and Wear Building Preservation Trust receiving a grant of £418,900 from the Heritage Lottery Fund, with cash also coming from English Heritage.

The 526-metre long listed staiths is a Scheduled Ancient Monument, and is believed to be the largest timber structure in Europe.



Dunston Staiths, weights © Damien Wooten

The newly-formed Friends of Dunston Staiths will run the weekly open days. The staiths are closed during the winter because, along with the adjacent salt marsh and mudflats, they are an important roosting site for a wide variety of birds.

Lottery Fund North East Area chairman and former Sunderland MP, Chris Mullin said: "We're delighted to see the reopening of Dunston Staiths. Thanks to national lottery players and the good work of all involved, the future of the staiths as a Tyneside landmark, and important link to our region's past, has been secured. The project will provide opportunities for the local community and visitors to access this heritage, as well as providing a safe haven for wildlife."

The restoration work was carried out by North East civil engineers Owen Pugh Construction, whose project team undertook land based repairs to remove and replace damaged timber, as well as more challenging work involving structural repair work over water.

Lee Buchanan, contracts manager at Owen Pugh Construction, said: "We're really proud of the work