Hams Way

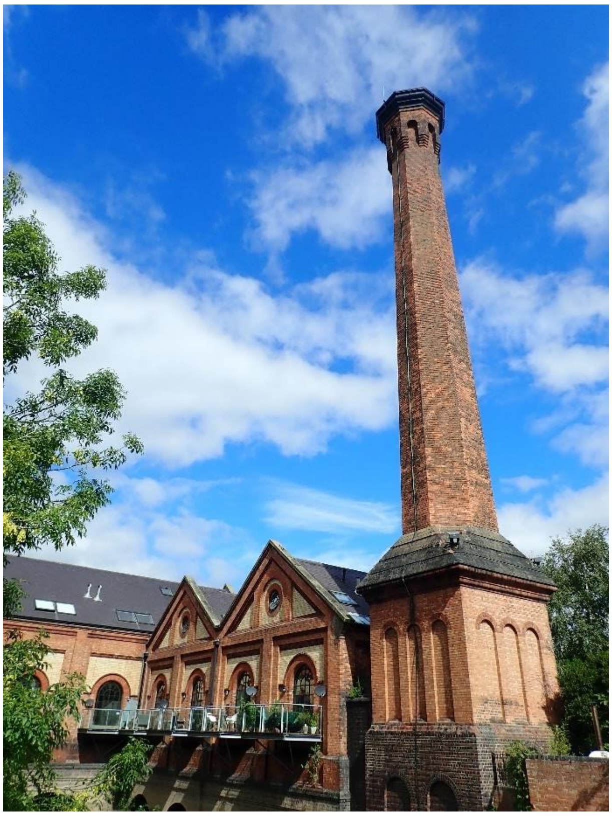
Finn Graham
COWI
figr@COWI.com

Situated adjacent to the meandering River Teme, the Hams Way site is located on the cusp of the ever-growing National Cycle Route 46 to the south-west of the historic town of Worcester. An existing pedestrian signal crossing links the walking and cycle route from Worcester Town to the Malvern Hills Area of Outstanding Natural Beauty. The need for an elevated link over the busy A4440 road is evident from the increased usage of this area by walkers and cyclists as they seek to lose themselves in this historic landscape.

The site is located in a particularly sensitive setting and deserved a balanced approach to design. It was once the location of the Battle of Worcester, the last battle of the English Civil War dating back to 1651. The site is surrounded by historically important infrastructure including the Old Powick Bridge (15th century) and the Powick Mill Hydro-electricity chimney stack (19th century, Fig 1). The site is located on a floodplain that experiences regular flooding throughout the year and is home to some beautiful and well-established tree species such as field maple and silver birch.

The sensitivity of the site required a delicate balance of stakeholder engagement in order to find a solution that was both visually attractive and functional, yet sensitive to important sightlines and the historical setting. COWI and Moxon Architects worked with Worcester County Council, the Environmental Agency, Historic England and various other stakeholders to develop such a design (see Fig 2).

The high-load route necessitated long approach ramps to link the existing path from the Old Powick bridge to the expanse of agricultural land to the west. The alignment was carefully chosen to link the footpath from the Powick roundabout to form a three-way earth embankment on the north side. The ramps are hidden from road-view by vegetation but allow the user to gain expansive views over the floodplain that were otherwise hidden. Flood modelling of the area was used to maximise the use of vegetated earth embankments without compromising flood levels for future generations.



1. Powick Mill Hydro-electricity chimney stack dating back to the 19th century, located 200m from the bridge

2. Photomontage showing the minimalistic impact the bridge has on the landscape

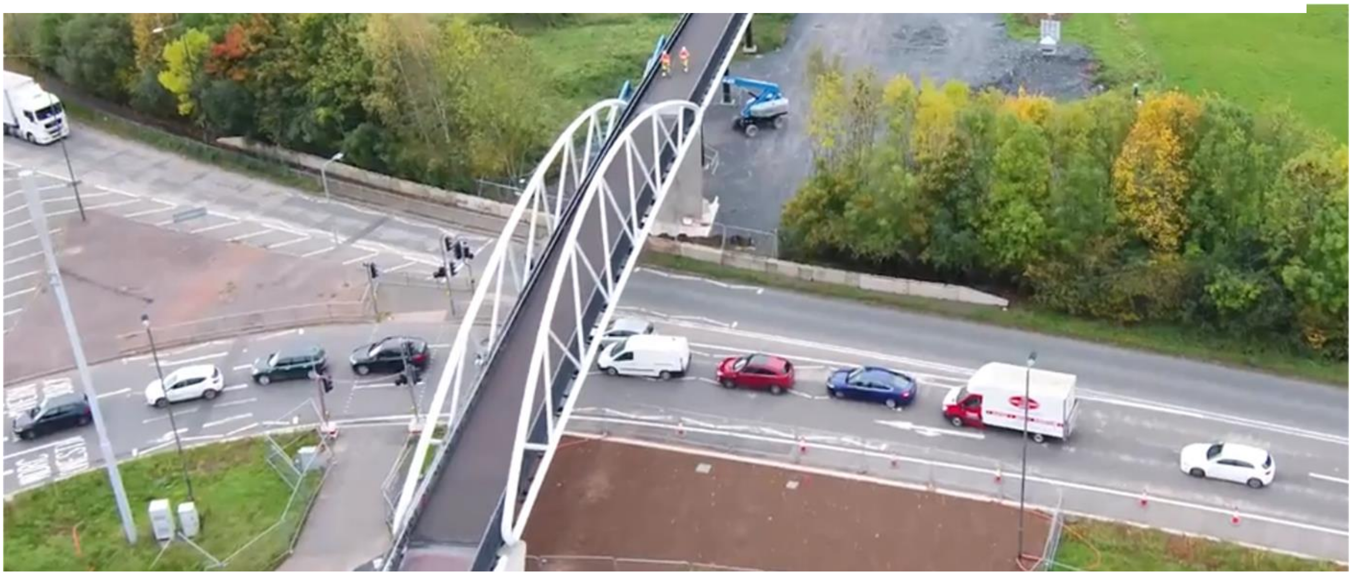
Bridge concept

The combination of form and function led to a bowstring truss being adopted for the main crossing. The arched form was selected to fulfil Worcester County Council's aspiration for consistency among the family of arched structures dotted around the area. The web diagonals provide additional stiffness to avoid an unacceptable pedestrian dynamic response which can often be a challenge with lightweight footbridges in this span range.

The chords and diagonal members are formed from square hollow sections rotated through 45 degrees. They are designed to catch light on their upper surface and cast shadows below creating a playful balance of light and dark. The off-white colour of the arch blends with the sky and contrasts with the dark colours of the deck and parapets.

The 6m-high trusses lean inward and are unbraced to give a dramatic user experience when approaching on foot. Rolled universal beam sections make up the intermediate deck crossbeams and provide "U-frame" stiffness to restrain the top chord from out of plane buckling.

The ends of the bridge feature a tightly formed curve in the transition from top to bottom chord. This hides the supports that might usually be present at the springing of an arch and gives the impression that the bridge rests effortlessly above the sloping piers.



3. Drone view of the bridge nearing completion

4. Bridge being transported into place on a self-propelled modular transporter unit from the site welding compound adjacent to the road

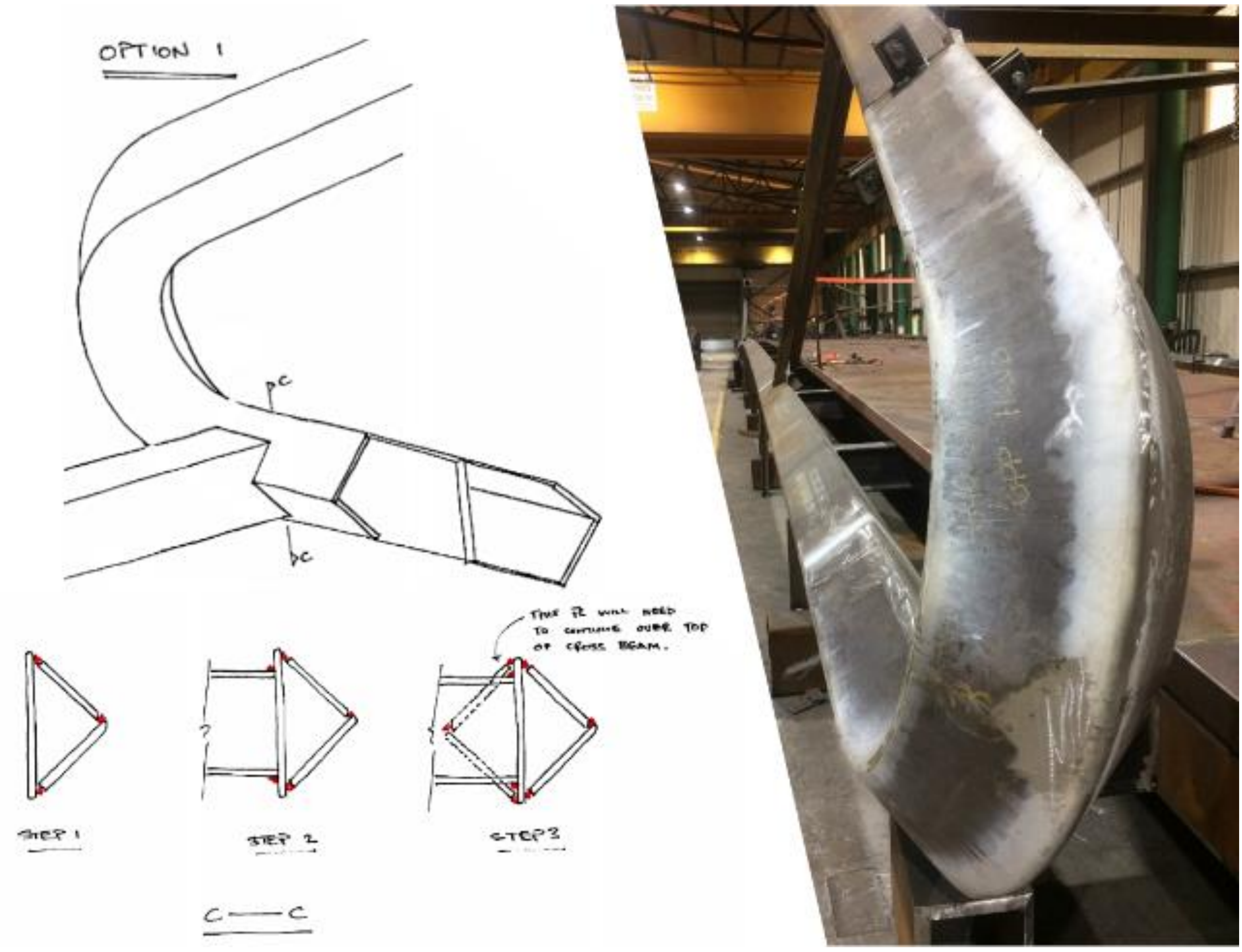
The approach spans mirror the design principles of the main span throughout. This is most evident where the two meet, the approach ramp kissing the main span with a similar end curve detail. Given the overall length of the elevated approach spans, an economic solution that reiterated the design simplicity was required. A repetitive pattern of 12m modules was adopted using slender steel columns as supports. The long-term maintenance issues associated with bearing replacement were avoided by making the steel columns integral with flexible shallow foundations.

The parapets are formed from a panelised system of profiled plates which lean in opposite longitudinal directions on either side of the bridge – the angle chosen to match the slope of the central hanger on the mainspan. The parapets frame the approach and main crossing when viewed along the bridge yet appear transparent when viewed transverse. This transforms the bridge into a viewing platform along its length with clear views across the floodplain.

Simple solutions to complex problems

As is often the case for steel footbridges, the numerous small details occupy vast amounts of time both in terms of design and fabrication. Hams Way Footbridge was no different in this regard. Through close collaboration with the steelwork fabricator, the design team were able to simplify many of the complex construction details whilst maintaining the architectural values of the scheme. Having developed the design at an early stage to incorporate these rich architectural features, the challenge during detailed design of the bridge was to find elegant engineering solutions to preserve the aesthetics and retain the original design intent.

One of the most striking features of the mainspan is the curved end sections where the top and bottom chords meet. Designing this architectural feature to be both strong and stiff enough to resist the internal forces as well as being pragmatic and buildable was one of the more complicated aspects of the design. Although the curve is a continuation of the hot rolled chord sections, the radius is far too small to achieve by cold rolling. This end node is formed of individual flat and conically curved plates welded together. The top/bottom chord transitions from a hot rolled section to a plated section approximately 1m from the start of the tight curve. The plated section consists of a diamond profile with a central vertical plate, the outer dimensions matching the profile of the chord (Fig 5). This provided both the strength and stiffness required to transmit the forces around the curve, resist the out of plane buckling torque from the top chord, as well as providing a useful guide for welding. The fabricated end crossbeam connects directly to the inner vertical plate with the rest of the chord profile slotted around it. This solution results in singly curved conical plates which could be laser cut and bent from flat plate using traditional techniques. The beauty is that the complexity of this detail is completely hidden within the steelwork.



5. Concept sketch of the end curve formation and how the end crossbeam is connected to the bottom chord

6. Left: early stage render used to communicate the design to the many stakeholders. Right: site photo showing the bridge nearing completion.

The inward leaning unbraced top chords are an important architectural feature of the main span. Restraint is provided using a combination of "U-frame" action mobilised by both the out-of-plane stiffness of the diagonals and the torsional stiffness of the chord restrained at the end curve. The rotated square hollow section hangers are required to transfer out-of-plane moment through the bird-beak connection at the intersection with the rotated bottom chord. Due to the concentration of forces in this localised region, as well as the interaction of the stiffness of the end curve, extensive non-linear FE modelling was undertaken to confirm the buckling behaviour of the top chords.

Digitalisation

Visualisations of the bridge were ultimately an invaluable asset for stakeholders to make informed decisions at early stages of the project (see Fig 6). Sight lines, aesthetics, lighting levels, and health and safety hazards were amongst the many criteria for the planners. The design team also challenged standard practice with regards to creating and sharing cloud based BIM models with the contractor and fabricator to enhance assembly model production and reduce overall cost on the project.

Conclusion

Hams Way Footbridge is a good example of how bridge elegance and simplicity can be one and the same. Digital tools were utilised to effectively communicate early stage design intent to the many stakeholders to form a strong architectural basis for the scheme. Complex detailing was then delivered in a simple way through good collaboration across the design and construction teams.