Soho Loop

Cantilever Footbridge

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DYSE

STRUCTURAL ENGINEERS

The Brief

Project overview

The new Soho Wharf Development has brought 750 new canal side homes to Birmingham city. As part of planning conditions, the developer Galliard Homes had a requirement to deliver a new footbridge to connect the development side (Left of image) with the far side tow path to the Old Main Line Canal (Right of image).

The client's vision was to bridge through the canal side parapet of the existing Eyre Street Basin masonry arch bridge at the apex.

Scoping

DYSE encountered the scheme in April 2021 when being asked by their client Beaver Bridges to attend a site walkover with the Canal & River Trust to discuss the possibility of a new bridge. The key restriction became immediately obvious upon visiting that it would not be sensible to found the bridge eccentrically on the side of an existing masonry arch barrel.

Though news to DYSE, the concept of a cantilever footbridge had been discussed. The client had no incentive to deliver a bridge of any uniqueness but needed a solution. The idea was one that could not be guaranteed on the spot but needed confidence gaining; typical cantilever bridges only support their self-weight in this mode but carry traffic loads in a simply supported arrangement.

An efficient and lightweight form with good openness of elevation seemed essential leading very quickly to the conclusion that a truss was the way forward. Basic preliminary sums fairly quickly gained confidence on likely vertical deflections under extreme crowd loading and horizontal deflections under wind. These gave indications on dynamic behaviour. Buckling was not a critical concern with compression at deck level.

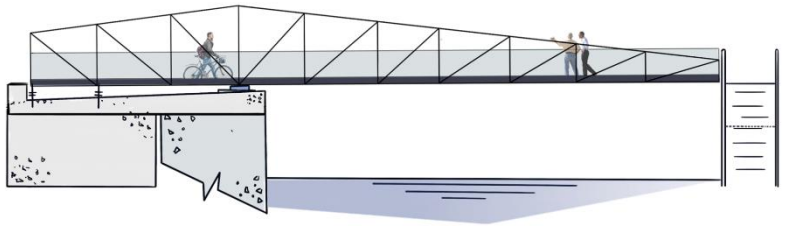
The Concept

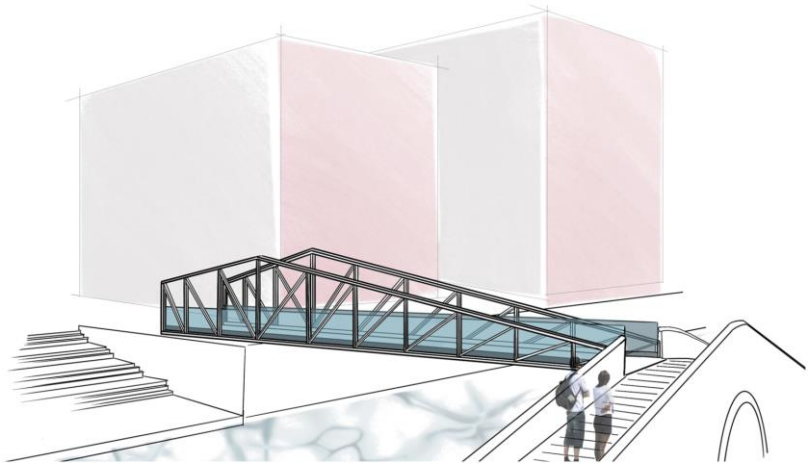
With belief gained, a proposal was made that started off with a feasibility stage to develop the concept, explore layouts and illustrate how the bridge would look. Once instructed, DYSE carried out this development. Key features of the bridge to realise the concept include:

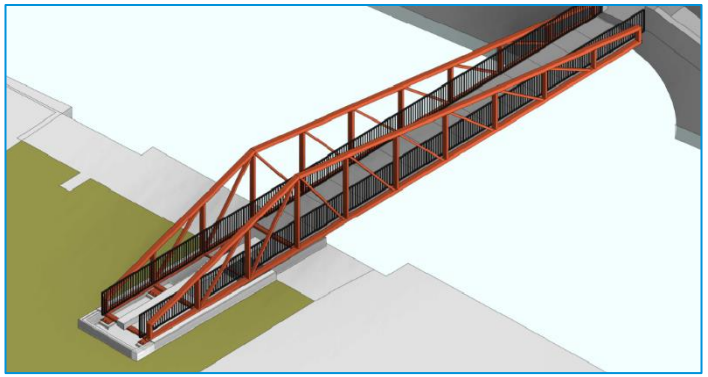
- A 14m^3 concrete kentledge to act as a counterbalance.
- Four holding down clusters that could be used for levelling with simple tools inspired by bases to roadside cantilever structures.
- A proprietary aluminium movement joint to manage the interface with a new landing at the apex of the canal bridge, typically used for floor to floor covers between movable floor plates.
- Pot bearings to the central support over a repurposed canal wall.

The concept sought to achieve a form that accentuated the cantilever construction with a truss that tapered below parapet level towards the tip whilst remaining very stiff and lightweight.

Initial works on the scheme involved concept development alongside surveys to establish feasibility including coring of the existing developer side canal wall to prove solid for repurposing and establishing depth of oil filled cables running under the tow path. DYSE went on to deliver all stages of design and carried out on site supervision during critical stages of construction.







A. Feasibilltiy → B. Startup and Surveys → C. Outline Design → D. Detailed Design → E. Construction

The Design

A robust strategy in relation to construction sequencing and levelling was essential to meet the challenges of a fully cantilevered span.

The strategy was made as clear as possible with 3D construction sequences and levelling technical notes providing critical information and guidance on what behaviour would be expected. DYSE provided on site guidance and supervision during the key stages of the installation.

Ensuring temporary stability was paramount for safety from load transfer off the mobile crane to being finally held down at the kentledges. As part of the strategy, the kentledge was cast as far in advance as possible to mitigate settlement concerns. The bridge was then landed on jacks supported off the kentledge to allow it to be adjusted to get the correct level of the tip prior to final tightening.

The temporary works were designed by DYSE. DYSE's successful concept for temporary stability was to load the bridge with temporary precast concrete vehicle collision barriers in a Jenga arrangement to the rear to form a temporary counterweight prior to final levelling.

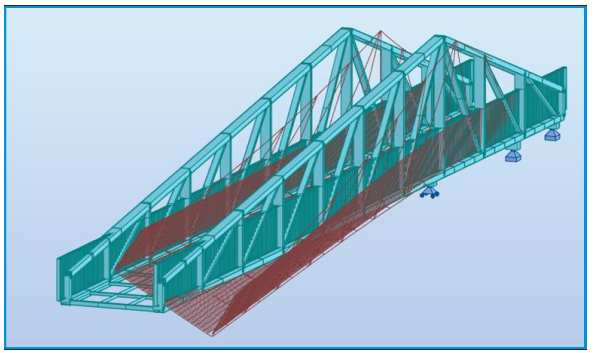
During design, a parametric study looked at producing the most lightweight and elegant structure possible whilst meeting the needs for sufficient stiffness from vertical pedestrian loads, lateral wind loading and dynamic response (the first mode being torsional at 3.4 Hz). The weight of the steel was reduced to 24t or only 0.9 t/m. This in turn also allowed the kentledge weight to be minimised.

DYSE worked closely with the design and build contractor and fabricator, Beaver Bridges, to ensure the design was buildable. The bridge was delivered as a single 27m long assembly to site through a busy construction site.

Removable deck panels allow access to undertake levelling as necessary. A maintenance guide was provided for the health and safety file to explain how this would be achieved if ever necessary.

The construction had an embodied carbon of only 926 $kgCO_2e/m^2$.

The scheme was estimated to achieve a SCORBS rating of A.



Reflections

Designing bridges is a privilege in that it allows for some of the greatest expression of the art of structural engineering. This project presented this in a pure form that made it the most enjoyable design of the career of the author of this paper so far.

The project was a unique opportunity to do something original. Though there is nothing new in the cantilever bridges per se, inspiration was not sought first from typical non-static equivalents such as swing or bascule bridges. However, inspiration was sought from outside of bridging for many of its features and its erection.

Despite all theory and calculation showing that the design would be stiff and serviceable, and indeed would not fall into the canal, there was admittedly a certain fear from the author about how the bridge would respond in reality and an equal excitement to experience it. The fear was expelled when the DYSE team visited for the first time (cover photo) on the July 2023 annual summer trip and the bridge was reassuringly stiff.

Some compromises were made in design. The bridge was delivered to a budget with practical open parapets deemed most appropriate by the wider team. Professional architectural involvement could certainly elevate the concept further where the client has aspirations for a landmark bridge.

The biggest surprise from the initial visit is that the bridge fits into its industrial surroundings more than can be claimed as fully intended. From observing reactions from the general public on social media, it is clear that there is a sense of fun to experience it and the bridge has become far more than just a crossing to fulfil a condition. It is hoped that this system will find another case for use and there is opportunity to enhance the design further.

Project Team

Client - Galliard Homes Limited

Permanent Works Designer - DYSE Ltd

Temporary Works Designer - DYSE Ltd

Category 3 Checker - Cake Engineering

Principal Contractor - Beaver Bridges Ltd

Technical Approval Authority - Canal and River Trust