The Rotherhithe to Canary Wharf Crossing

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Figure 1 - View of Canary Wharf and Rotherhithe from the North

A new bridge for East London

The Rotherhithe to Canary Wharf (R2CW) Crossing was planned to connect Canada Water and the Isle of Dogs. The bridge would have been the first new structure downstream of the iconic Tower Bridge and, with a span of 181-metres, the world longest movable pedestrian and cyclist footbridge.

The forecast of growth in cycling across London, employment growth in Canary Wharf, population growth in Canada Water and the limited capacity of the Jubilee Line are generating increased travel trips by foot and cycle.

This led Transport for London (TfL) to consider the delivery of a new river crossing. Having explored a range of bridge, tunnel and ferry options, TfL established that only a navigable bridge would deliver upon the active travel objectives set out in London's Healthy Streets Policy and the Mayor's Draft Transport Strategy. Following an initial design stage that concluded that the opening mechanism should be a vertical lift bridge, TfL appointed a team to develop the design for consent through a Transport and Works Act Order process.

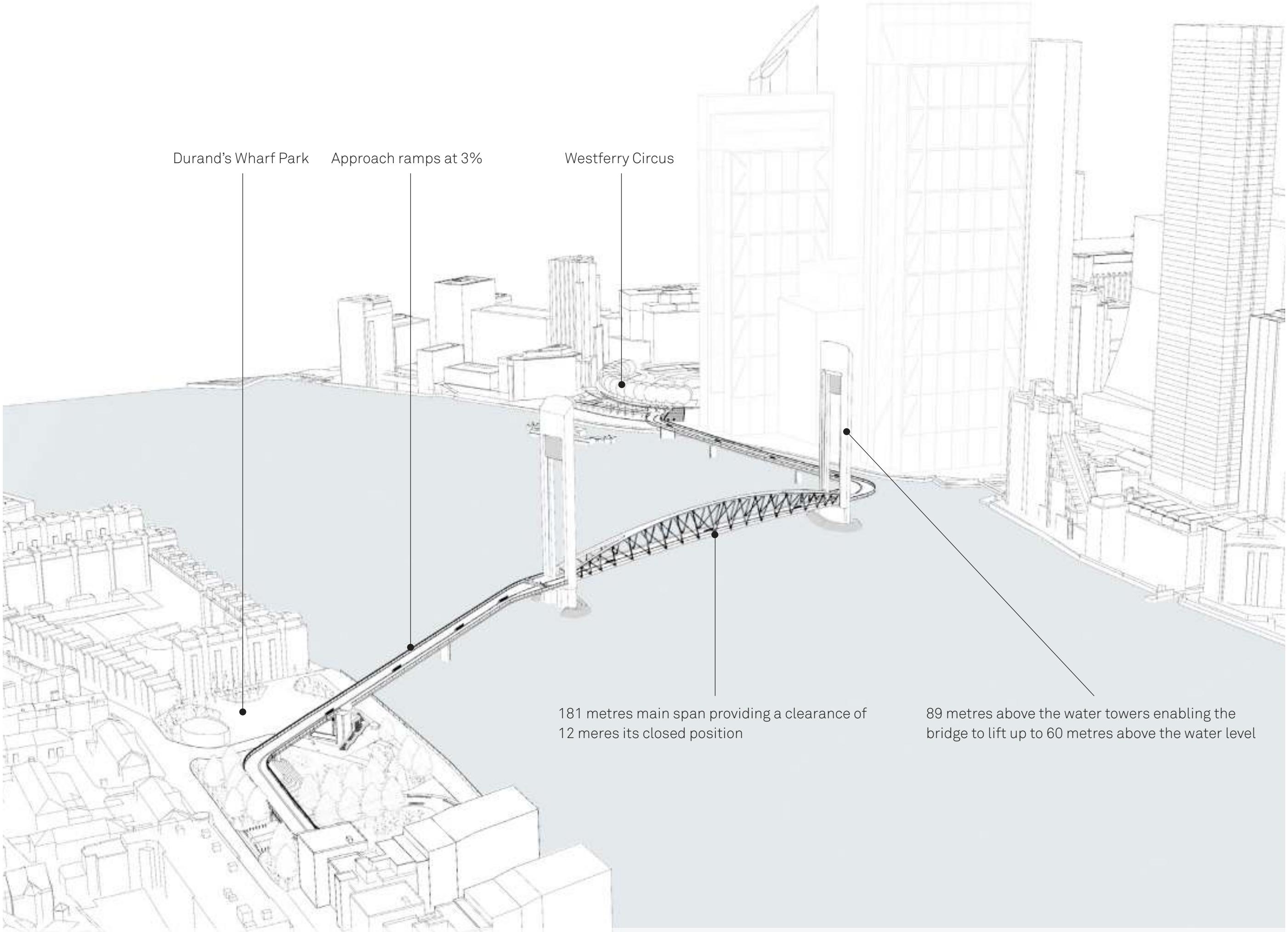

Figure 2 - View of the scheme from Rotherhithe to Canary Wharf crossing the River

An attractive crossing for all Londoners

It was clear from the outset that designing a bridge of this scale in a constrained urban location was a unique challenge. It put extraordinary demand on the structural engineering solution and the operating mechanism, which had to be highly efficient, safe and reliable. However, the crossing also had to address its sensitive and important context with an elegant, fitting and memorable solution in response to the unique and diverse characteristics of the two sides of the river.

Rather than beginning with the questions surrounding the solution, the 'what' and the 'how', the team considered the questions surrounding the challenge, such as 'who is the crossing for?'. This new crossing was to serve cyclists, pedestrians, and people with reduced mobility. The most important measure of success would have been the number of users. The bridge had to be as attractive as possible to the maximum range of potential users across as broad a time range as possible.

To achieve this, it became quickly apparent that one of the key drivers was to define the correct height of the bridge. This factor would have informed how desirable it was to cross, and therefore how much it was used. Higher alignments are more challenging to cross, requiring longer ramps and additional lifts, lower alignments open more often to allow vessels to pass. Due to the length of the crossing, standards and guidance relating to gradients and ramps were reviewed and questioned. A 3% gradient for cyclists for any length of ramp, and with level landings every 0.5 metre rise, for pedestrians and wheelchair users was recommended.

The height also influenced the visual scale of the crossing, opening mechanism, cost and environmental impact. After an extended consultation with the Port of London Authority a fixed height of 12 metres above Mean High Water Spring (MHWS) level was agreed.

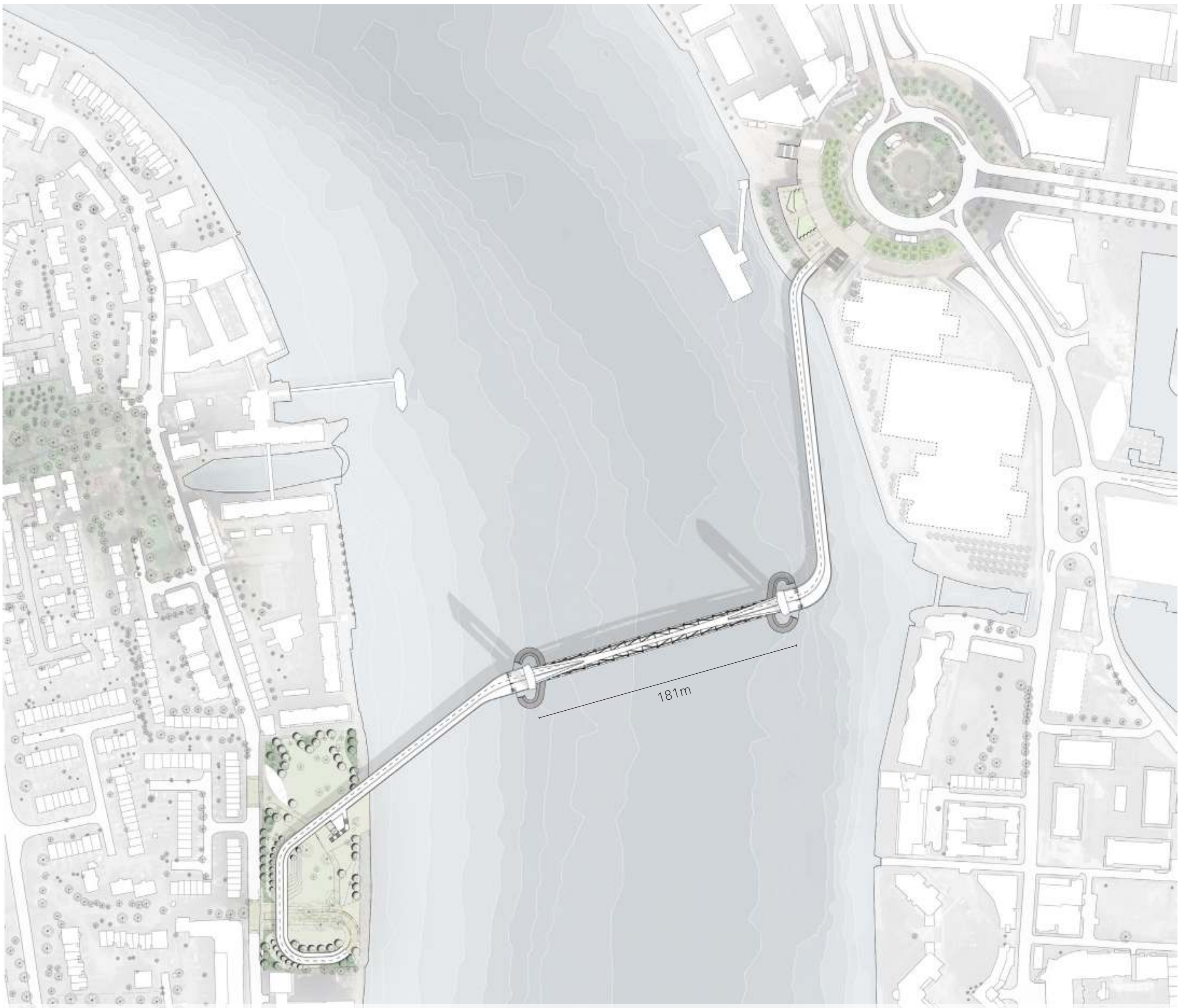

Figure 3 - Plan view of the Rotherhithe to Canary Wharf Crossing

A unique design challenge

The scheme was a 741 metres route from Durand's Wharf in Rotherhithe to Westferry Circus in Canary Wharf. The alignment spanned across the Jubilee Line tunnels and the 124-metre-wide navigational channel, resulting in a 181-metre-long moveable main span supported by two lifting towers located on either side of the channel. The main span provided 12 metres vertical clearance above the MHWS level for the central 40 metres, which could be raised to 60 meters above MHWS for the full width of the channel.

With such a length, a through truss offered the most efficient solution. This lightweight structure guaranteed that the bridge would lift quickly, efficiently and reliably.

To ensure this new structure would respond and merge within its surroundings cityscape, largely defined by the tall modern towers of Canary Wharf, it was clear we would have to step away from the traditional design of long-span truss and design it to respond to the unique characteristics and challenges of the crossing. Another significant design challenge was to mediate between conflicting scales; it had to meet the technical requirements of a bridge of this scale but also work at human scale to provide a positive user experience. As such, the elements forming the truss had to be well-proportioned with a clear and positive hierarchy, allowing the truss to be legible from both within and distant views.

Figure 4 - Visualisation from the main span, showing the design of the truss and deck arrangement

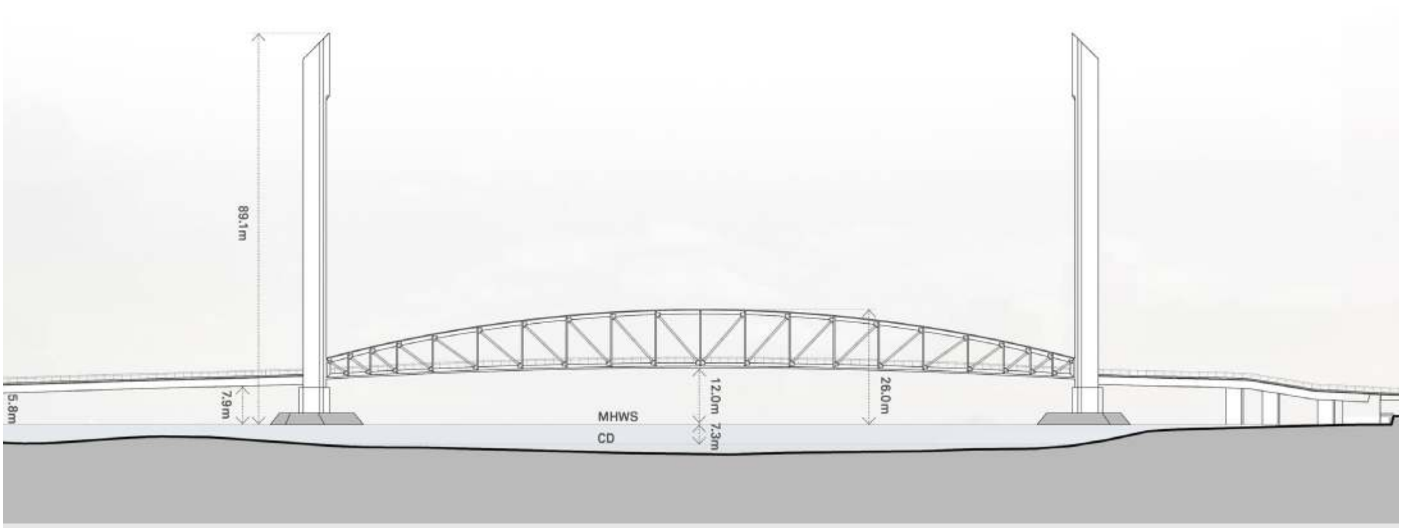

Figure 5 - Elevation of the Rotherhithe to Canary Wharf Crossing, showing the design of the truss and of the towers

In order to achieve an acceptable proportion and hierarchy, the diagonal members were to be formed of two pairs of steel tension rods, which allowed redundancy and much smaller diameter elements to be used in comparison to tubular sections. This enabled the truss to appear elegant and unobtrusive from surrounding viewpoints, whilst maximising transparency for users on the deck. These members would have also demonstrated the forces within the truss, clearly portraying themselves as tension elements – a visual clarity which is often lost on tubular trusses. End connections added interest and appropriately-scaled detailing, avoiding the visual clutter associated with an excess of welded connections. The vertical truss members were to be formed from rounded rectangles. This shape section was to give a rhythm to the internal longitudinal views, whilst maximising transparency for lateral views on the deck and elevational views of the structure.

The truss featured incline sides, which tapered to a slender top chord, maximising the visibility of both the surrounding viewpoints, and the journey ahead. Given the length, and the subtle rise and fall of the deck, the top chord of the truss dropped down into distant views. In order to make sure these views were uninterrupted, at the ends of the truss, the top chord split apart to meet the tower legs and lift cables, creating an opening which maximised views down the deck to the route, and cityscape beyond.

Fig. 6 - Visualisation of the main span and lifting tower

Like the main span, the towers faced the same challenge of blending in, the characteristics of a large-scale movable bridge, within an urban river crossing environment. The two towers were to rise uninterrupted 89 metres above the water line, with the 8.86 metres wide bridge deck passing through their apertures. The lifting mechanism was concealed within the concrete tower base, with the ropes or sheaves running up and down the inside tower's legs. At the top of the towers, the feature counterweight revealed the lifting capabilities of the bridge. As the bridge deck went up, the counterweight descended. The towers were portal frames in elevation, each comprising of two legs that came together and merged just before the top platform level to provide space for the pulley system. This stable portal frame shape allowed pedestrian and cyclists to pass through the towers from the approaches to the main span and vice versa. The legs were T-shaped in section, allowing them to provide lateral and longitudinal restraint to the main span deck and counterweight.

The towers were stiffened using ring stiffeners at each landing level with bracing provided to resist horizontal wind load at the top of the towers and to support the bridge lifting equipment. A couple of short decks spanning between the towers legs of each tower provided transitions between the main span and the approach spans, and the landings for their respective expansion joints.

The design of the bridge was the perfect example of efficient and innovative structural and mechanical engineering solutions and of thoughtful collaboration between a large multidisciplinary team. It was a constant iteration process to develop the most efficient, legible, cost effective and consentable design. This was particularly demonstrated in the design of the towers, where by challenging the M&E requirements, we were able to reduce their height and upper mass, creating a more efficient, minimalist shape with a lower visual impact and cost efficiency.

A bridge for the future?

In June 2019, TfL Programmes and Investment Committee made the decision to pause the project as the expected costs of the scheme were seen to be considerably higher than anticipated and therefore not affordable in the short term.

The R2CW crossing is still seen as the best solution in the long term to provide a much-needed new cross river walking and cycling connection East of Tower Bridge. When constructed, it will be a great piece of engineering and architecture within an urban location, and will provide a safe, attractive and direct route for pedestrians and cyclists, reducing journey times and encouraging healthier travel in line with the Mayor Transport Strategy.