WestConnex Concord Rd to M4 West On-Ramp

The WestConnex Concord Rd to M4 West On-Ramp is a continuous, 5-span, 213m long twin steel composite girder bridge supported on mechanical steel pot bearings with a maximum span of 60m. It had to be designed for both vertical and horizontal curves, with a tight horizontal radius of approximately 80m. In addition, the steel girders sit on a constant 5% crossfall, while the road surface transitions from 5% to 3% superelevation. The constant cross fall means that through the horizontal curve, the bottom flange was fabricated in a conical shape.

The bridge was constructed over live traffic on Concord Road and the M4, replacing the double left turn movement from Concord Road to M4 Westbound and providing direct access to the M4 from Concord Road.

Design

Steel bridge construction allowed a slender, elegant profile that was accentuated by its horizontal and vertical curvature. The bridge design includes open steel troughs on straight spans, top lateral bracing on curved spans for torsional stiffness, bottom flange stiffeners with low gauge plate and use of concrete stitch pours allowed the use of steel construction without the disadvantages of welding or bolting on site. Every element was modelled in 3D, allowing coordination between steelwork, precast panels, deck reinforcement and shear studs.

The steel girders were 1.8m deep within the 60m span (2.8m at supports) and 1.6m deep at the 40m spans (unhaunched). The 80m horizontal radius is a very tight curve which causes eccentricity of support resulting in torsion, thereby suiting the use of structural steel. The steel section varied in depth and included haunches at supports to achieve efficiency in the design.

Modelling

Every element was modelled in 3D, allowing coordination between steelwork, precast panels, deck reinforcement and shear studs. The 3D model was modified as elements were constructed on site to reflect as-built deviations from design. This allowed a 'digital trial' of the components of the bridge before erection, which in some cases allowed alteration in the workshop, thus minimising alteration and rework on site.

Construction and Constructability

The use of concrete stitches between girders strengthened the case for steel construction by removing the need to bolt or weld over live traffic. The speed of construction was greatly enhanced by placing prefabricated steel girders and precast deck concrete before setting up parapets and in-situ concrete.

The construction methodology utilised two steel temporary towers. One, in the middle of the M4, was not released until after composite strength had been achieved, minimising deflection of the bridge. The use of steel temporary towers during the construction staging enabled M4 traffic switching to occur during construction, taking into account the construction of the interchange rather than just the bridge in isolation. One, in the middle of the M4, was not released until after composite strength has been achieved, minimising deflection of the bridge.

Standard thickness steel plate with typical welding details have been utilised with an industry leading steel fabricator, resulting in ease of information interpretation and implementation. Temporary steel brackets and lifting lugs were designed and detailed to ensure safety during girder erection.

Sustainability

The use of structural steel resulted in a much lighter bridge than equivalent concrete box construction. Iron is one of the most abundant of all the earth's elements. Steel is also readily recyclable in the future without the loss of property of performance. Therefore, steel allows a 'circular economy' where we can recover and repurpose much of the construction material at the end of an asset's life. This represents the sustainable management of natural resources where the embodied energy in the steel can be re-utilised.

The lightweight nature of steel also resulted in fewer site visits from heavy vehicles, which in the context of the congestion on the M4 and Concord Road, resulted in a significant reduction in emissions from additional trucks and congestion.

PROJECT TEAM

- **Architect:** HASSELL Studio
- **Structural Engineer:** AEH
- **Head Building Contractor:** CSJ JV
- **Steel Fabricator:** S&L Steel
- **Steel Distributor / Manufacturer:** Liberty
- **Coatings Supplier:** Dulux
- **Steel Detailer:** Elmasry Steel Design & Detailing