Award

RIVER USK CROSSING

Newport Southern Distributor Road

Architect Yee Associates **Structural Engineer** Faber Maunsell Ltd **Steelwork Contractor** Fairfield-Mabey Ltd
Main Contractor Morgan-Vinci **Client** Newport City Council

The new Usk River Crossing is a landmark bowstring arch bridge forming the centrepiece of Newport's Southern Distributor Road (SDR). The 9.5km SDR links M4 Junction 24 to Junction 28 and will provide relief to congested local roads and enhance cross river capacity. It is also intended to act as a key catalyst for local regeneration. Construction of the whole project has lasted two and a half years and at £55m it is the largest local Private Finance Initiative (PFI) scheme in Wales.

At concept stage a number of options were considered, with the arch finally being selected as most appropriate both symbolically and technically for its urban setting and historical context. A single clear span of 187m provided the best environmental solution, avoiding any permanent piers in the river. The arch form adds to the City's family of notable bridge types and ties in with the city's desire to develop a riverside walk linking the bridges. Newport's industrial heritage is reflected by the choice of steel for the bridge's construction; however, the design is distinctly modern.

Steel is the natural choice for a bridge of this span and type and is used for the primary elements of the superstructure – the arches, the hangers and all the deck beams. The bowstring arch is an efficient structural form that places minimum lateral loads on the foundations. Reinforced concrete is used to provide an economic deck slab, and this acts compositely with the steel beams.

The steel arch members are rectangular in cross section and are parabolic in elevation, tapering in depth towards their apex. They are inclined to convey a sense of enclosure and visual stability. The inclination gives the composition visual interest since the hangers will appear to crisscross when the bridge is viewed from an angle.

The bridge has been delivered by a unified team of designer, main contractor and steelwork contractor, with advice from the architect. This relationship has been a key to the success, and has enabled the design to be carefully tailored to suit not only the preferences of the steelwork contractor and erector, but also respond to the need for the contractor to maintain the bridge for the next 40 years.

Durability was therefore a key issue, which has been addressed in a number of ways. All steelwork above deck level was formed in box sections with no exposed ledges, to promote a clean design. The external surfaces of all the steelwork were treated with a high performance epoxy based paint system, with all box sections being fabricated from weathering steel and left unpainted internally. Weathering steel was utilised for the box members to avoid the significant safety issues associated with applying paint within a confined space, including eliminating the need for future maintenance painting. However, the small additional cost of the steel was more than offset by protective treatment savings.

The steelwork contractor created a fully detailed 3D computer model of the bridge, as input to his automated plate cutting and drilling machines. This model incorporated the significant computed deformations anticipated during erection.

Judges' Comment

The Usk crossing symbolises the best in British bridge engineering. It combines an elegant design, high quality fabrication and innovative construction.

The box girder arches, with inclined parabolic form, are fabricated in weathering steel, externally painted and provide long-term maintenance benefits.

Its elegance belies the 200 metres span.

The majority of the deck structure comprises a simple ladder-beam grillage formed from fabricated I sections, to make the most economical use of the steelwork contractor's automatic 'T & I' machine. For the arch, a careful examination of the economics demonstrated that the best solution lay in a rectangular section that was not stiffened longitudinally.

The river has dictated the approach used to erect the bridge. The size and weight of the structure was beyond the capacity of any available cranes to erect in one piece, and so a decision was taken to place two temporary piers in the river, at approximately third points of the span. The River Usk has the second largest tidal range in the world and work

time in the river was significantly limited to suit ecological constraints to cater for migratory fish including salmon and the rare chad.

The erection of the superstructure followed a carefully developed sequence. The steel deck structure was assembled in two halves on either side of the river, utilising the pilecaps for the approaches as foundations for the temporary towers. Each half was then launched out over the river, crossing the temporary piers to meet in the middle. Temporary towers were erected on top of the temporary river piers, and a 1200 tonne capacity mobile crane lifted the outer arch sections such that they landed at the abutment and out onto the tower tops.

The central section of the arch was too heavy to lift directly into position, and so it was moved on skates to the centre of the bridge in sections and then welded together to form a single 680 tonne piece which was then raised to its final position using strand jacks. Once all welding was complete, the arch was lowered off the temporary towers to become free standing ready for installation of the hangers.

The initial stressing of the hangers lifted the deck off the temporary piers and was followed by the placing of the precast concrete deck panels. Using precast deck panels enabled most of the weight to be added such that the movements and deformations in the steelwork could take place in a controlled manner. In particular, the tie girder was expected to stretch by about 125mm, which if constrained by a partially constructed insitu concrete deck could produce uncertainty in load paths and cracking of the concrete. Final adjustment of the hangers was carried out before the stitches were concreted.

In conclusion, Newport has gained not only another much needed river crossing, but has gained an elegant steel structure in the process.