Award

CTRL 103 - MIDLAND MAINLINE BRIDGE DECK A

Kings Cross/St Pancras

Architect Rail Link Engineering **Structural Engineer** Rail Link Engineering **Steelwork Contractor** Watson Steel Structures Ltd **Main Contractors** Kier Nuttall Joint Venture **Client** Union Railways

The Midland Mainline Bridge, links the West Coast Main Line with both the Channel Tunnel Rail Link and the newly refurbished St. Pancras Station. The bridge is a skewed Warren Truss/Arch spanning almost 50m with a centre depth of 9m and a width of 15m. The weight of the bridge is approximately 1000 tonnes. Watson Steel Structures were awarded the contract for the manufacture and installation of the bridge in March 2002 with completion date of June 2003.

Two major design constraints affected the design and choice of materials – how to minimise future maintenance of a structure in place over a major arterial electrified railway corridor and how to place the bridge there in the first place. The first was satisfied by the use of weathering steel to fabricate the lower portions of the deck where future maintenance of a painted structure would be extremely difficult. The second by assembling, welding and painting the deck in an area behind one abutment and then launching it across the railway lines during a 55 hour possession over Christmas 2002.

The two main girders are Warren Trusses with a curved top boom which also benefits from the arch action. The top booms are orientated as an H with 55mm thick webs and 105mm thick flanges and the diagonals are 930mm deep plate girders with 40mm flanges all fabricated from Grade S355 plate.

The bottom boom of the trusses are 2.0m deep plate girders with their 45mm thick bottom flanges in weathering steel, their 60mm thick webs in subgrade J2G3 and their top flanges in Hyzed steel plate. The cross girders, also fabricated from weathering steel plate, are approximately 15m long with webs shaped to create a drainage fall away from the centreline of the deck.

The deck was shop fabricated in large elements weighing up to 45.5 tonnes. The bottom booms were fabricated with a dead load pre-camber and trial assembled together with their cross girders to ensure a correct fit for site welding. The booms were then laid on their sides and the arch sections and diagonals also trial fitted. Both the bottom boom and arch sections were provided with integral run-on, run-off plates on their "trouser legs" and these were match drilled during the trial assembly to allow the arch to be assembled at site with the diagonals bolted using temporary cover plates. To avoid transverse on-site FSBW's in the arch member webs and flanges, the ends of each member were machined during fabrication and trial fitted to ensure full bearing thus allowing a smaller PPBW's to be used. The weight of the arch sections was supported on temporary props during welding.

There was insufficient room behind the abutment to assemble the bridge and so it had to be assembled 'off-line' and then rotated into its final position. There were further complications in that part of the launch nose had to be removable during the rotation phase to avoid it clashing with an existing building and the concrete structure behind the abutment was unable to support the weight of the rear of the deck so it had to be supported on the bearing shelf whilst it was rotated into its final position.

The deck was partially concreted prior to the launch and this ensured that any future concreting works could be undertaken without the need for an isolation of the railway. The concrete also contributed to the stability of the deck during the launch although additional concrete kentledge blocks were needed to achieve a satisfactory factor of safety.

The bridge was launched using a combination of 500 and 1000Te hydraulic skid shoes running on tracks on concrete ground beams and fabricated steel beams supported on steel columns founded on piled foundations. The skid shoes were self-powered and allowed the bridge to be driven forward over the railway lines until one corner was directly over its bearing position. This corner then formed the pivot point for the subsequent rotation.

The supports during the rotation phase were additional 1000Te skid shoes that moved along tracks founded on the bearing shelf. These supports not only had to move along the bearing shelf but also allow the bridge to rotate and slide longitudinally above them during final positioning. Strand jacks attached to the end of the main bridge girders were used to facilitate this longitudinal sliding movement.

When the bridge was above its final position, the load was transferred onto climbing jacks and timber cribbages and then progressively jacked down. As soon as the bridge was sufficiently stable to be supported on four single climbing jacks, the structural bearings were installed and attached to the undersides of the main girders and end trimmers. The bridge was then jacked down to its final level and locked off to allow the bearings to be grouted.

Judges' Comment

In the congested site outside St Pancras and King Cross Stations; the planning, logistics, design and fabrication skills of the team were pushed to the limit in the construction and final positioning of this structure.

The low-maintenance bridge, of 1,000 tonnes, 50 metre span fully welded warren trusses, will link the West Coast mainline to the Channel Tunnel Rail Link. An impressive achievement.

This bridge has provided the client, Union Railways, with an aesthetically pleasing, low maintenance structure installed with minimal disruption to existing infrastructure and services.