JOURNEY'S END

The short life of the 1,550t A-shaped tower that forms the main structural element of the New Wear Crossing has been a dramatic one so far, involving three countries, one sea journey, a canal trip, a river jaunt, three barges and 12 SPMTs. José María Sánchez de Muniáin reports on its manoeuvres

The tower for the new cable-stayed bridge in Sunderland, northeast England which has travelled some 600km as a single element, completed the last leg of its journey to site under the cover of darkness, with few spectators and no public announcements. As *Bd&e* went to press it was due to be raised vertically in a dramatic operation, to take centre stage on the new US$150-million cable-stayed bridge that is being constructed over the River Wear.

The New Wear Crossing is a 336m-long, 25m-wide cable-stayed bridge with a main span of 240m formed by two-lane carriageways and a dedicated cycle and pedestrian routes. Construction began in May 2015 and it is currently on track to open in spring 2018. Once the bridge is complete it will be part of 2.8km of new road that will improve access to the A19 and A1 motorways from Sunderland's city centre and port. The crossing is also expected to open up land in the region of Tyne and Wear for regeneration and future development and is claimed will help to create up to 6,000 new jobs.

Sunderland City Council is the client and the general contractor is joint venture FVB, formed by Farrans Construction and Victor Buyck Steel Construction. Engineering services are being provided by Buro Happold Engineering and Roughan & O'Donovan; specialist transportation is being carried out by Sarens.

The bridge's single A-frame tower is quite different to the dramatically curved 'bulls horns' of the concept that won the design competition in 2005. The city's plans to build the winning design were ditched after construction estimates soared, and the bridge was scaled back to a simpler design that did not create so many challenges for the contractors.

Nevertheless the revised structure, which stands 105m high and weighs in at 1,500t will provide an impressive centrepiece for the bridge once it has been vertically raised. According to the contractor, nothing of this size has been lifted in this way in the UK since the London Eye in 1999.

The tower was fabricated at Victor Buyck's yard in Bumar, Belgium, and the first step of its complex 600km journey to Sunderland was a modest 100m manoeuvre on to twin barges for a 5km-long journey to the Port of Ghent, an operation that was carried out by Sarens in December last year.

A total of six multi-wheeler SPMTs comprising four, eight-axle units and two, ten-axle units were used to hydraulically raise the tower off its supports and then transport it to the first of two barges that would take it onwards. Sarens director of technical solutions, Carl Sarens, explains that two river barges had to be used because there was no single barge with dimensions suitable for navigation through Westbekesluis Canal's narrow and low bridges.

On day one of the operation the tower was carefully manoeuvred top-section first onto a barge; next day a second barge was positioned in front of the first, and the tower was carried forward onto it, top-section first.

With the canal closed to traffic the Karel & Victor and Josef & Rosa barges took only three hours to reach the busy Port of Ghent, where they remained for six days, waiting for a window of opportunity for the next lift, which was subject to navigation times and barge traffic.

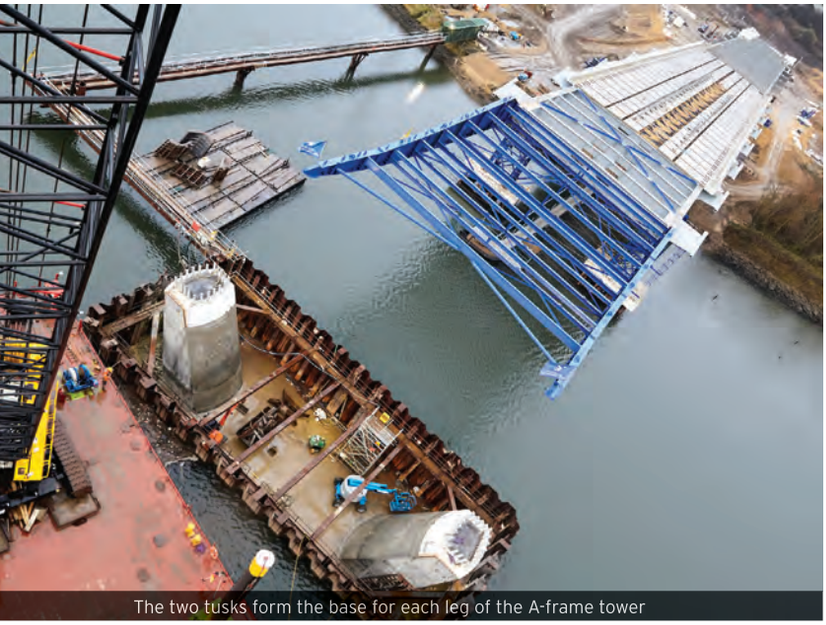
The next leg of its journey, to the port of Sunderland via the Ghent-Terneuzen Canal which links Belgium to the Netherlands and the North Sea, required the tower to be transferred from the twin barges to a single sea-going barge.

This complicated manoeuvre involved additional multi-wheeler SPMTs in the form of four high-load 12-axle units and two six-axle units positioned on Sarens' sea-going barge, the 100m-long, 33m-wide Louis.

A wide enough gap had to be created between the two canal barges for the sea barge to back into, after which the SPMTs were carefully positioned underneath the central section of the tower.

The canal barges were then ballasted at the same time as the Louis was de-ballasted, enabling the SPMTs to take the whole weight of the structure and the steel frame positioned across the tower legs: "One of the big challenges was ensuring the centre of gravity was right in the centre of the SPMTs," comments Sarens: "Having the right geometry and centre of gravity was vital due to the high stresses in the locations where we picked it up." Once it was supported by the SPMTs and free of the river barges, the tower was then slowly rotated through 90° to its final longitudinal position on the Louis.

Two days later on 5 January, propitious weather allowed the tower to embark on its sea voyage, arriving at the port of Sunderland two days later. Here, a number of preparations were undertaken, including a change of ballasting from marine to ▶


The two tusks form the base for each leg of the A-frame tower

river trip configuration, as well as the installation of scaffolding that had been planned to ease the installation of the cable stays at a later stage of the construction process.

"The river phase was a big challenge – it was a big barge on a small river and on top of that we had some nasty curves as well as very little clearance at the bottom. So we had to go at high tide otherwise we would have got grounded," says Sarens, speaking of the tower's 5km trip up the River Wear.

At its final destination the tower was greeted by the sight of half the bridge deck supported over the river, as well as two tusk-like vertical structures rising 8m above the cofferdam. These tusks, made from 38t of reinforcing steel and 150m^3 of concrete, will form the base for each leg of the tower, whose foundations and pile cap had been formed by a pour of 1,500m^3 of concrete back in August.

The steel framed bridge deck has been built in two phases at the assembly platform near the southern abutment. It hit its first key milestone in mid October, when the first half was launched during a seven-hour operation. Two hydraulic strand jacks pulled the 2,500t structure across the river by 120m, using PTFE plates as bearings.

The deck assembly for the first launch had a length of 173m and consisted of 212 precast concrete units; 18 longitudinal beams measuring 15m by 1.8m; 14 anchorage consoles and 43 transverse girders of 20m by 2m.

To ensure that the permanent works were not overstressed during launch, a 37m-long lightweight launch nose was used to compensate for the deflection of the large cantilever, enabling the deck to be picked up at the temporary support towers and recover the deflection. A 7m-long launching tail, or heel, carried out the same function at the rear of the deck. Eight pairs of temporary supports were used during the first launch; eleven will be used for the second. Work assembling the second half of the deck started immediately following the launch.

Once the tower is in place in the middle of the River Wear, the deck will be launched through its legs and 112m onwards to the north embankment. The distance between the inside face of the tower leg and outside face of the deck is around 3m. "Once the bridge comes onto the tower it will go onto its launch bearings, which will guide the deck through. As the deck passes through the tower it will do so in a controlled alignment," explained Stephen McCaffrey, project director of the FVB joint venture.

After the final launch the nose and heel will be removed and the last 40m of the crossing, on the north bank, will be constructed conventionally by the craning of steel beams into position. This will be followed by the installation of the precast concrete deck panels, the welding of the deck to the tower legs and the installation of the cable stays. Prior to this stage however, there remains the challenge of lifting the tower from the barge and onto the tusks that will be forming the connection to its foundations, an operation that was planned to take place as *Bd&e* went to press.

In order for the tower's legs to line up with the bridge tusks and create sufficient space to enable the lifting procedure, another careful 90° rotation similar to that which took place in Port of Ghent will be required of the SPMTs aboard the barge.

"Within the tusks there are number of anchorages and elements that will help support the tower as it is being erected," says McCaffrey, adding: "We have fabricated a hinge that will sit at the bottom of the pile and which will be supported by temporary works. As the tower is pulled up it will be rotated around the hinge to arrive and land on top of the tusks."

As the hinge is key to the methodology of the lifting operation, McCaffrey explains that a great deal of effort has gone into its design, particularly how it will interface with the temporary supports it will be bearing on while the tower is being shifted, and how it will interface with the steel tower. "It looks like a conventional hinge with a hinge pin through the middle, says McCaffrey. "One half connects to the supports and the other to the tower. It rotates from a horizontal position to a vertical one; a safe and controlled way of erecting the tower."

A back mast fixed to the tower will be used as the lever arm to begin the rotation to the vertical position, which will be carried out by strand jacks connected to foundations anchored to the ground on the south side of the river bank.

Anchor bolts will then be installed and the tower bolted temporarily for up to eight months, after which reinforced concrete will be poured around the tower legs to complete the permanent connection between the reinforced concrete tusks and the steel tower.

After the deck is across the river, the next and final challenge will be removing the temporary works from the river – a difficult proposition as there will be no easy access for heavy plant due to the bridge's overhead presence. Although river barges remain an option and have been used on site throughout construction, their use is limited by the tides, with high tide being the only time that the river becomes navigable.

In contrast with the well-publicised notification of each of the previous stages of the A-tower's journey, the final 5km took place in the dark, under a cloak of secrecy.

The perfect navigation window had been identified as being in the early hours of the morning of 19 January; in order to avoid safety issues associated with spectators gathering by the banks of the river in darkness, the decision was made not to inform the public. The 24 hours that will be required to raise the tower on to its tusks, however, will afford Sunderland with plenty of opportunity to enjoy the spectacle

The tower arrived at the Port of Sunderland in January after a two-day sea voyage