



RAISING EXPECTATIONS

The float-in and erection of a 183m-long steel truss span over the Ohio River is just the first of several dramatic milestones in the replacement of the Milton Madison Bridge. **Murray Johnson** reports

A temperature of 40°C was not enough to deter residents of the small towns of Milton, Kentucky and Madison, Indiana, from lining the banks of the Ohio River recently to watch a new steel truss span being raised slowly off barges on to temporary piers. Three days earlier, the 1,520t span, which was assembled on barges alongside the Kentucky shore, had been floated into position and connected to bundles of high-tensile strand hanging from eight large strand jacks. When the lift was finished, the span had been raised 26m above the river and placed on massive steel box girders. These are temporary pier caps that will later become sliding girders for the final operation, during which the entire bridge will be moved from its temporary construction alignment to its permanent position.

This first lift of one of the two main river spans of the new four-span continuous truss bridge, was the culmination of months of preparation; truss assembly, permanent pier rehabilitation, and temporary pier construction. In turn, it will be followed by a second lift of an even larger span, and then the two remaining spans will be cantilevered towards the abutments from the erected river spans. Once the steel structure is complete, the concrete bridge deck, footway, and barriers will be added and the new bridge roadway temporarily tied into new approaches now being constructed. Then the traffic, which has been using the existing bridge through construction, will be diverted onto the new bridge to allow the old superstructure to be demolished. Finally, after completion of the new pier caps on the rehabilitated pier stems, the entire 740m long new superstructure will be slid 17m sideways into position on the new pier caps, during a short traffic closure.

This unusual and innovative construction scheme came as a result of the bidding process; the bridge replacement was tendered in June 2010 as a design-build project with particular limitations. The bridge owners, jointly the Kentucky Transportation Cabinet and the Indiana Department of Transportation, had studied the bridge replacement extensively with engineers and had ultimately developed the concept of rehabilitating most of the existing piers and replacing the superstructure.

Superstructure replacement became the preferred option at the environmental impact assessment stage, primarily because it required no new right-of-way acquisition, minimising the impact on the two towns it connects. In particular, Madison in Indiana is a very historic and picturesque little town, with a large historic landmark district.

Financing issues also supported the superstructure replacement option; the project was awarded a US Federal Government Transportation Investment Generating Economic Recovery or Tiger grant of US\$20 million. To be eligible for these grants, projects had to be able to be completed by a certain date. When the owner's engineers established that the existing pier foundations were suitable for a larger bridge with rehabilitation of the pier stems and caps, this and the design-build delivery method combined made the shorter schedule more viable, enabling the project to qualify for the Tiger grant as well as making the solution more economical.

The design-build tender call was issued with some specific restrictions, including that the new bridge be a four-span continuous truss of similar appearance to the original bridge, and that it be a superstructure replacement, using four out of five existing piers, which were to be rehabilitated.

The existing 1929 steel truss bridge which is very narrow and has no emergency lanes or footways, was functionally obsolete, and was deteriorating. However it is the only bridge over the Ohio River over a 116km length and consequently is a vital link.

To limit the time the bridge would be out of service, tender requirements included a time component which was used in establishing the effective bid price. The design-build contractor was given the option to close it for a maximum of 365 days, but for each day the contractor proposed to close the bridge, an extra US\$25,000 was added to the bid price, as an incentive for fast construction. In addition the contractor was obliged to run a ferry service while the bridge was closed.

While other bidders allowed for the maximum bridge closure of 365 days, the team of Walsh Construction, Burgess & Niple and Buckland & Taylor came up with the sliding



Above: The first major operation under way. Left: The new span on top of the temporary piers

scheme which allowed them to bid a total closure of just ten days, a difference which won the job when figured into the bid formula. Within the US\$103.7 million contract, Burgess & Niple are responsible for designing the concrete approach spans and the rehabilitation of the piers, with Buckland & Taylor carrying out both the design and the construction engineering for the steel main spans.

As part of the erection of the four spans of steel trusses, totalling 740m in length, it was decided to build the two main river spans on barges and float them into position, then lift them into their temporary position using eight 330t strand jacks, two at each corner of the span, supplied and operated by VSL. The jacks are supported on pairs of lifting beams raised on supports above the temporary and permanent pier.

The two full-span lifts include some particularly challenging aspects. The nature of the truss configuration precludes shortening the lifted portion of the span, as is often done for other bridge types, to allow it to be raised to the inside of the piers. Instead the lifts at Milton Madison are made without the end floorbeams and bracing installed, allowing the truss bottom chords to extend past the pier panel point and 'bracket' the temporary pier tower during lifting. Temporary bracing, set so as to clear the supports, is installed to take the place of the missing bracing and provides stability.

Another challenge is maintaining a connection between the permanent concrete pier and the temporary pier tower while the truss is lifted between them. These connections, for stability and geometry control, consist of steel frames which are provided at two levels to accommodate the truss. At the start of the lift, the upper level frame was in place and the lower frame was swung down out of the way. The truss span was raised up close to the underside of the upper frame and locked off, then the lower frame was swung up beneath the truss and pinned to the pier. With this connection established, a section of the upper frame was removed and the truss lifted through. The lift was halted with the underside of the huge truss bearing hanging 300mm above the top of the temporary pier caps/sliding girders, which had yet to be inserted.

The next challenge was the installation of the sliding girder, which could not be placed in advance because the truss had first to be lifted through it. Two portions of the sliding girder, the 'tines' which form a fork at the pier end of the girder to fit round the bearing location, were erected ahead of time on a platform between the truss chords. But the main body of the sliding girder, a steel box 2.6m deep and weighing 80t, had to be inserted from the downstream side of the temporary piers in a tricky balancing act.

Suspended from a floating ringer crane, 30m above the river, the girder was carefully

inserted into the face of the tower as far as the suspended truss would allow. There it was blocked into place against beams, and in a move that had the ironworkers' eyes wide open, the crane was released, leaving the massive beams cantilevered over the river, held in place by gravity. Ironworkers then walked out to the end of the girder to reconnect the crane, allowing it to support the tail of the girder while it was drawn through the tower on rollers. This operation was paused to connect the tine girders to the main girder, then continued until the assembled girder spanned to the temporary tower.

The truss span was then set down upon the sliding girders intended to support it in this temporary position, completed and carrying traffic, until it is time to slide the completed bridge. The bases of the permanent truss bearings, lined with PTFE for the sliding, were greased and then set down onto the polished top of the sliding girder. Temporary restraints against transverse and longitudinal movement were engaged in a careful sequence to maintain the span safely in place as it was landed on the girders.

The first float-out and span lift was completed over a period of several days, allowing plenty of time for the final truss assembly that was required, the connection of the jacks, and the various lifting and girder installation stages. The experience gained on this lift will be useful in making the second span lift successful. This span crosses the main navigation channel and the lifting procedure must be completed to a height sufficient to clear river vessels within an allowable closure period of 24 hours. Because the first span lifted occupies one of the piers, the configuration for lifting changes, with the strand jacks supported above the remaining temporary pier as before, as well as on beams set above the top chords of the trusses at the first panel point away from the pier. This second span, 222m long and weighing 1,900t, is scheduled to be lifted next month (September) and the bridge slide is currently expected to take place in April or May next year. Full completion is anticipated in the autumn of the same year

Murray Johnson of Buckland & Taylor is lead engineer responsible for the construction engineering of the Milton Madison Bridge.

Owners: Indiana Department of Transportation and Kentucky Transportation Cabinet
Design-build contractor: Walsh Construction
Main bridge design and construction engineering: Buckland & Taylor
Pier rehabilitation design and approach spans design: Burgess & Niple
Strand jack supply & operation: VSL International Switzerland