

# **Outstanding Infrastructure Project Award Recipient— Abraham Lincoln Memorial Bridge**

## **History**

The Abraham Lincoln Memorial Bridge, located in LaSalle, IL, is the longest bridge in the state, with a total length of 7122 ft (2170 m) and supported by 86 piers, 43 in each direction. The bridge is elevated approximately 70 ft (21 m) above the Illinois River and numerous local roads, lakes, wetlands, and railroads. The piers range from 50 to 100 ft (15 to 30 m) high, 41 ft (12.5 m) wide and 4 ft (1.2 m) thick at the caps, while increasing to 6 ft (1.8 m) at the base. The piers span between 135 to 165 ft (41 to 50 m).

## **Shotcrete Challenge**

The bridge was repaired in two phases. The southbound repairs began in 2007 and the northbound in 2008. The general contractor removed and replaced some 22,000 yd<sup>3</sup> (16,820 m<sup>3</sup>) of concrete on the bridge deck alone. The shotcrete contractor was contracted to repair the substructure following the Illinois Department of Transportation Structural Repair of Concrete Specification. The specification gives the contractor the choice of formed concrete repair or shotcrete.

Access to the piers below was severely limited to a 10 ft (3.0 m) area adjacent to live traffic while access on the ground was limited to only a handful of piers, but were inaccessible as they were surrounded by the Illinois River, wetlands, lakes, and the historic Illinois-Michigan canal. The substructure repairs were delayed until July 10, 2007, so that the general contractor could replace the first 600 ft (183 m) of bridge deck because the 10 ft (3.0 m) access lane was deemed unsafe and a potential hazard next to live traffic.

## **Plan of Attack**

For the piers that were surrounded by land, 70 ft (21 m) tall boom lifts were placed over the side of the bridge with cranes. As concrete removal started, it was immediately recognized that the project was going to exceed initial contract quantities. This required evaluation and authorization by the owner. This approval delay time was used constructively and engineered a safe way to raise and lower platforms that were placed just below the deck by the general contractor extending 50 x 6 ft (15 x 1.8 m) and weighing 6000 lb (2722 kg). These platforms were to be used at all finger joint piers over the river, lakes, and wetlands that were inaccessible.

A quick response from the owner in the first week of August 2007 was received approving additional quantities and concrete removal was set in motion at numerous piers. The concrete was removed past the first mat of steel while saw-cutting the edges and sandblasting using abrasive grit, taking great care to blast the saw-cut edges that were to be polished with the saw cut. Black reinforcing bar was supplemented as necessary and then the entire prepared area was inspected by the engineer for approval.

## **Shotcrete Solution**

All of the shotcrete work was done from the bridge deck, including the deliveries of pre-bagged materials. The water was hauled on site using 250 gal. (946 L) totes and the temperature monitored. The use of hot water in tote tanks in cool weather and the use of ice in warmer weather kept the material temperature consistently between 70 and 78 °F (21 and 26 °C). In addition, the use of canopies over the material and shotcrete pump aided in temperature control during the summer months while concrete blankets and heaters helped moderate the material temperature in autumn 2007 and spring 2008.

The freshly sandblasted surface (within 72 hours of shotcrete placement by specification) was prewet to a saturated surface-dry condition. The shotcrete was placed with 0.42 water/cement ratio, along with the addition of 10% by weight of 3/8 in. (10 mm) river rock. All of the work was completed by ACI Certified Nozzleman. The curing was done with cotton mats attached to the pier with 1 x 2 in. (25 x 50 mm) studs and interspersed with heavy-duty soaker hoses and gravity fed with water for 7 days. After 7 days of wet curing, the mats were removed and the structures were sounded by the engineer for acceptance.

Phase I (southbound) was completed mid November 2007 and Phase II (northbound) was completed August 29, 2008. The scope of work resulted in over 15,000 ft<sup>3</sup> (425 m<sup>3</sup>) of removal and replacement with high-quality shotcrete. The general contractor and the subcontractor are also proud of their safety record of zero accident reports while working 80 ft (24 m) in the air. All of the test results exceeded the specification's requirement. The shotcrete solution resulted in a long-term, affordable repair.

As in all highway projects, time is of the essence. The use of shotcrete and its versatility had many advantages compared with form and pump. One example was the ability to remove concrete on the piers in segments. On several piers that were severely deteriorated, 33% of the pier was prepared using shotcrete to place back, and was remobilized after it reached 70% of its strength and the procedure was repeated. This eliminated any concern for destabilization of the structure. The placement of a pre-bagged shotcrete material allowed a freshly-placed and a quality-adjusted, consistent mixture. Concrete that would have been used in formwork would have a short open time to work with after driving from the plant. There would have also been risk of a form blowout and polluting the wetlands. Shotcrete was also chosen for safety reasons. The air and water hoses going over the side offered considerably less risk than lowering and manhandling lumber in the mass quantities as necessary. Also, if a problem occurred with concrete placement in the middle of the patch and would be unreachable, it would require removal of the form.

The shotcrete placement by ACI Certified Nozzleman could be done the following day with sandblast or high-pressure water blast of the edge of patch. The shotcreting process allows a visual encapsulation of the reinforcing bar while pumping into a blind form could result with voids. The curing of shotcrete by use of wet cotton mats was superior to a form left in place.

Safety, time, quality, and money concerns all significantly contributed to the use of shotcrete by the Illinois Department of Transportation on the Abraham Lincoln Memorial Bridge. This project is also being nominated for the bridge rehabilitation contract of the year for the Illinois Department of Transportation.