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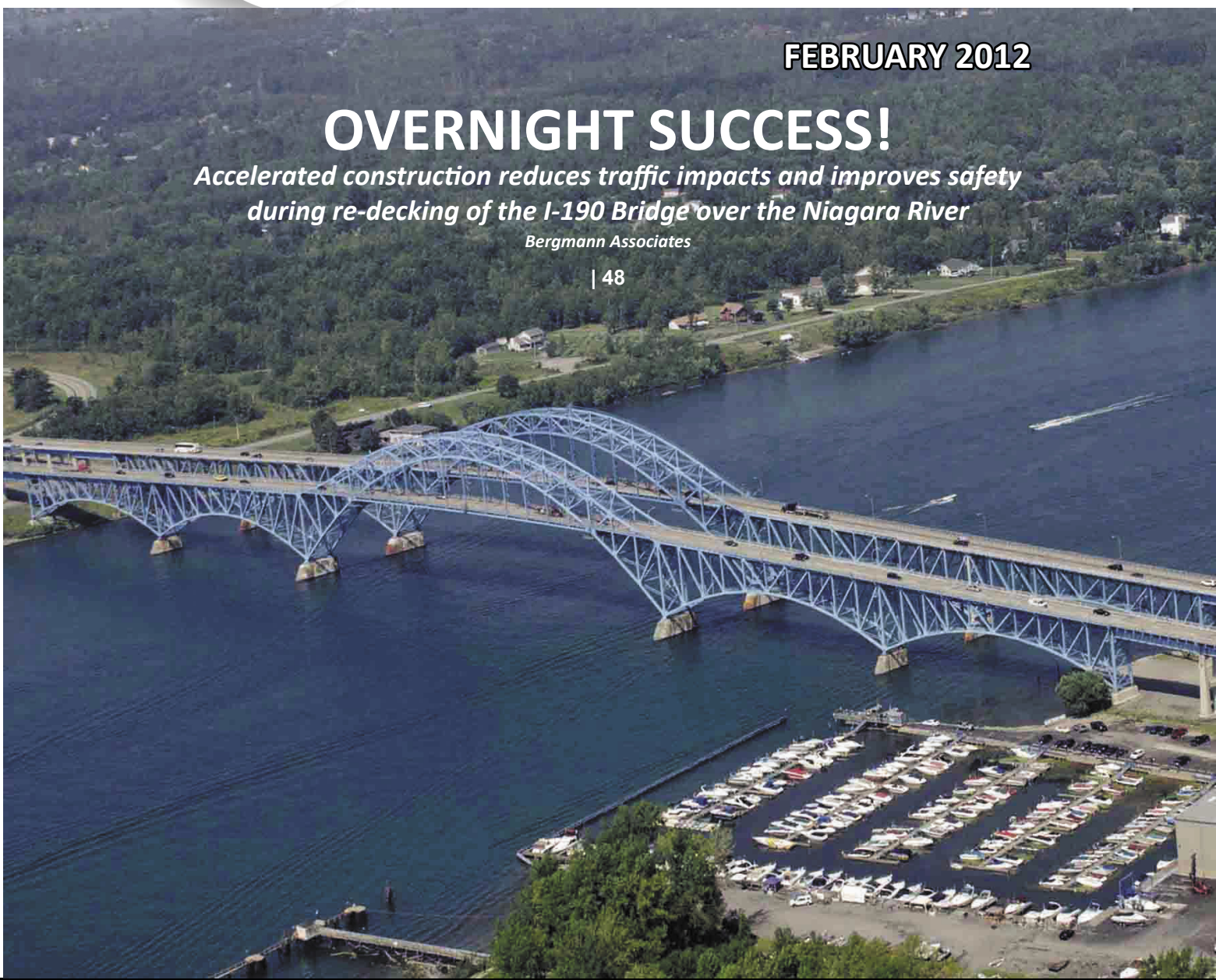

FEBRUARY 2012

OVERNIGHT SUCCESS!

Accelerated construction reduces traffic impacts and improves safety during re-decking of the I-190 Bridge over the Niagara River

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OVERNIGHT SUCCESS!

Accelerated construction reduces traffic impacts and improves safety during re-decking of the I-190 Bridge over the Niagara River

By: Mark G. Horschel, PE, Bergmann Associates

Precast Exodermic Bridge Deck Panel

Recently, the Federal Highway Administration has embarked on a new "*Every Day Counts*" (EDC) initiative designed to implement and encourage the use of innovation aimed at reducing congestion, shortening project delivery time and enhancing safety. In keeping with the spirit of the EDC initiative, the New York State Thruway Authority completed construction of a new panelized deck on the South Grand Island Bridge northbound in 2010 for a total cost of $48M. The bridge is 3,383 foot long and carries I-190 over the Niagara River at the southern end of Grand Island.

What made this project notable was fact that Bergmann Associates, the engineer of record, incorporated several accelerated bridge construction practices and state-of-the-art materials into the design of the re-decking. This significantly reduced the disruptions and congestion to the more than 77,000 vehicles that use the bridge each day and improved the safety of both the contractor's workforce and the traveling public during this two year rehabilitation project. Innovative, full-width precast concrete deck panels and barriers, cleverly detailed permanent and temporary closure joints as well as advanced materials in the form of rapid setting concrete and polymer overlays allowed the completed bridge deck to be replaced one section at a time during short overnight work windows allowing the bridge to be fully re-opened to traffic each morning.

Located between Buffalo and Niagara Falls is Grand Island, a small 30 square mile parcel of land located in the middle of the Niagara River. Up through the early twentieth century, the only way on and off of Grand Island was via ferry boats. But in the 1930s the island got a proverbial shot in the arm with the construction of two large bridges over the Niagara River, one at the south end of the island and one at the north end, opening up the route between Buffalo and Niagara Falls. These bridges, more than a mile in combined length, consist of large cantilevered main span trusses flanked by several girder spans, each carrying two lanes of traffic and a single sidewalk. Now easily accessible, Grand Island was opened up to new opportunity, development and commerce. By the 1960's traffic over the island had increased to the point where more highway capacity was needed and a second bridge was built adjacent to each original bridge, essentially twins their 1930's predecessors.

Since these bridges were built, continuous maintenance of the entire corridor has been necessary to provide a safe and economical means of access to and from the island. The northbound I-190 bridge at the southern end of the island featured a reinforced concrete deck when it was originally constructed in the 1960s, which was rehabilitated in the early 1980's to include a 2-inch thick concrete overlay. By 2008, the unrelenting pounding by the continuous traffic as well the exposure to the harsh Western New York weather and de-icing salts had taken its toll on the bridge deck, which was now at the end of its useful life and required replacement.

Bergmann completed rehabilitation plans in 2008 for the replacement of the deck and construction was completed in 2010. In addition to the deck replacement, the project also included concrete repair work to the substructures of the bridge, replacement of bearings supporting the 22 single-span girders, and other miscellaneous work. The project was constructed by the American Bridge Company.

This project required two construction seasons to complete. During the first construction season, in 2009, most of the substructure repairs were completed and the bridge bearings were replaced, so it wouldn't interfere with the deck replacement work, which was completed in its entirety during the 2010 construction season.

The challenges that had to be overcome during the design of this project were to: 1) develop details that would meet all code requirements, 2) have excellent longevity, 3) be low maintenance, and 4) allow construction work to be completed during overnight hours. This entailed developing details and utilizing materials that would allow the work to be completed one piece at a time each night and allow the bridge to be opened to two full lanes of traffic each morning. The deck, railing and curb had to be removed and replaced each night, so that it could be reopened to traffic each morning. The existing sidewalk was closed during the entire construction process, so the contractor was able to complete the sidewalk replacement as it fit his schedule. In addition, steel barriers had to be installed each night to transition between the existing bridge rail and new bridge rail. Transitions were also needed to transition between the existing bridge deck and the new bridge deck each night to accommodate cross slope and profile changes.

Each of the two South Grand Island bridges normally carries two lanes of traffic in one direction, either northbound or southbound. In order for the deck work to be performed, all traffic was removed from the northbound bridge and placed on the southbound bridge during each night's work. Traffic control plans were developed to place one lane of traffic, in each direction, on the southbound bridge when traffic volumes were low enough to be handled by a single lane.

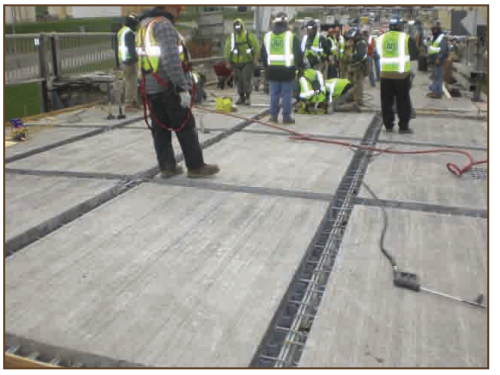
Precast Bridge Deck Panel Being Lowered Into Position

The contractor was usually allowed to begin the transferring the traffic from the northbound bridge to the southbound bridge at 9 PM. The daily start time varied depending on the time of the year and was as early as 8 PM on some days. Traffic volumes vary by the time of year and are generally higher in the summer when vacationers frequently visit Niagara Falls and other area attractions. The contractor was provided lane closure charts that indicated the exact time each day that the transfer of traffic could begin. The reopening of the bridge to two lanes of traffic each morning was always at 6 AM to accommodate volumes associated with commuter traffic.

The contract documents were developed so that the contractor would be working five nights per week, Sunday through Thursday evenings, but he completed most of the project working four nights per week, Monday through Thursday. Liquidated damages were included as part of the contract documents. Liquidated damages were assessed for not opening the bridge at 6 AM each morning. The liquidated damages for not opening on time each morning were as follows: $500/minute from 6:00 to 6:30 AM, $1,000/minute after 6:30 AM with a maximum assessment of $125,000 per day. Although the contractor was significantly late re-opening the bridge to traffic for the first few nights of deck replacement, there were no significant delays throughout the remainder of construction.

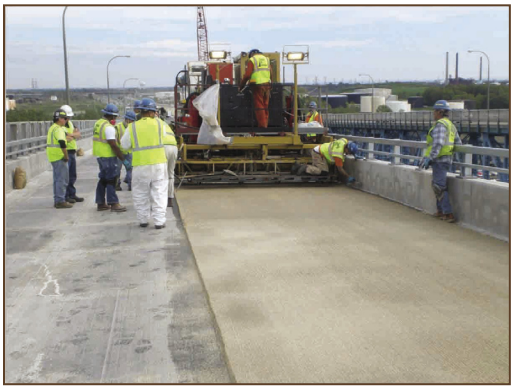
After evaluation of a number of deck alternatives, the Exodermic™ bridge deck system (patented by the D. S. Brown Company) was selected for this project. The Exodermic™ bridge deck is comprised of a reinforced concrete slab on top of and composite with, an unfilled galvanized steel grid. Composite action is developed through partial embedment of the main bars into the concrete slab. The deck slabs were precast, creating modular units ready for installation on the bridge. The precast concrete deck was omitted in the areas of the panel that were directly over the flanges of the supporting stringers and floorbeams. Panels were set on the supporting steel framing and adjusted to proper elevation with built-in leveling bolts. Positive attachment of the panel to the supporting steel framing was accomplished by installing stud shear connectors through blockouts in the precast concrete. The blockouts were then filled with rapid-setting concrete. Some of the advantages provided by the Exodermic™ deck system include: fast installation, lighter weight than the existing reinforced concrete deck, HS25 live load capacity, and the steel grid is created with standard structural WT shapes, reducing fabrication costs.

Precast Bridge Barrier and Railing System Being Lowered Into Position



Precast Bridge Deck Panel Ready for Grouting of Closure Pours

Automatic Shot Blasting Equipment Used to Prepare the Deck Panels for the Overlay



Installation of Polyester Polymer Concrete Bridge Deck Overlay

After evaluating a number of materials, a special specification was written for rapid setting concrete and grout. The specification required the use of CTS Cement because, when used in a properly designed mix, it can gain strengths of 3000 psi in 30 to 45 minutes. Rapid setting concrete was specified for the closure pours between the exodermic bridge deck panels, the deck haunches and the closure pours in the parapets of the new railing system. Rapid setting grout was used in the shear key between the railing parapets and the deck.

After all the deck panels were placed during the 2010 construction season, the deck was diamond ground to obtain a uniformly textured deck surface and to remove any minor irregularities before placing the overlay. The overlay was a ¾" thick polyester polymer concrete (PPC), supplied by Kwik Bond Polymers, which was included to reduce chloride intrusion and provide a uniform wearing surface. The PPC reached compressive strengths of 3000 psi in about 2 hours. Prevention of chloride intrusion is dependent upon the performance of the overlay material to resist cracking and delaminating. PPC has a very low permeability and is a flexible material. PPC is a polyester resin based material, with added aggregate, and contains no Portland cement. During curing, it transitions through a phase where shrinkage occurs. This phase is 100 percent complete within the first hour of curing, and therefore does not continue with time. A thin coat of a high molecular weight methacrylate (HMWM) was used as a primer before the PPC was placed to seal any shrinkage cracks in the concrete surface of the Exodermic deck and act as a primer for the placement of the PPC. Pull tests of polyester overlays indicate that rupture occurs within the concrete deck, not in the overlay.

Utilizing this accelerated bridge construction technique and unique materials, the entire deck, parapet and railing system was replaced on the bridge in one construction season. Approximately 90,000 square feet of deck was replaced. Since all work was completed with nighttime operations, when traffic volumes were low, very little disruption to traffic occurred.

Mark G. Horschel, P.E., is a Senior Project Manager with Bergmann Associates, and has 33 years of bridge design experience.