Segmental Concrete *Solutions*

by Craig A. Shutt

The Victory Bridge in New Jersey was completed more than two months ahead of schedule. Photo: ©FIGG.

Accelerated bridge construction (ABC) is often associated with short bridges or short-span bridges and moving full-span components into place quickly. But ABC techniques also apply to longer-span structures, including segmental concrete bridges. These concepts aid in rapid design and construction of bridges, which save costs and minimize disruption to the travelling public. Here are four examples:

Victory Bridge

ABC techniques have been in development for some years, as can be seen in the Victory Bridge on State Route 35 across the Raritan River between Perth Amboy and Sayreville in New Jersey. The state's first segmental box-girder bridge opened fully to traffic in September 2005—more than two months ahead of schedule.

Even more impressive, the first of the twin structures opened to traffic just 15 months after the notice to proceed was received. The second bridge was completed nine months later, according to a report in the Spring 2006 issue of *HPC Bridge Views*.

The bridge's parallel structures feature main spans of 440 ft, a U.S. record for fully match-cast segments. Two side spans on each bridge are 330 ft, while the approach spans vary in length from 142 to 150 ft. The balanced-cantilever method was used to erect the main and side spans, while the span-by-span approach was used for the approach spans. This helped speed the erection process and hasten delivery.

Other techniques that helped speed delivery included creating bid documents that were significantly more detailed than usual. This allowed the contractor to work directly from the bid documents rather than create shop drawings, saving both time and money.

The bid documents included details of reinforcement bends, segment geometry, and tendon-stressing sequences. They also included electronic files with integrated three-dimensional color drawings for some of the elements. Using this method, the first segment was cast just six weeks after the notice to proceed was issued, getting the project off to a fast start that continued to completion.

Earnest F. Lyons Bridge

The span-by-span approach to segmental designs also can speed construction, as was shown by the Ernest F. Lyons Bridge in Stuart, Fla. The twin, two-lane bridges were completed eight months ahead of schedule.

The 4600-ft-long, bridge features 30 spans at 152 ft plus a first span of 100 ft. Typical segments were 10 ft long, 10 ft deep, and 61 ft wide. A typical span consisted of 15, precast concrete segments, post-tensioned together using ten 19-strand tendons. The spans subsequently were made continuous into six-span units.

Despite a permitting process that took two months longer than anticipated, construction was still completed ahead of schedule. Construction delays and some damage also resulted from Hurricanes Frances and Jeanne passing over the site.

Three casting beds were set up to cast the 501 segments. Two beds cast typical segments, while the third was created to be interchangeable for pier segments and expansion-joint segments. The precaster used high-early strength concrete and transversely post-tensioned the top slab as soon as possible, allowing beds to be stripped every 12 hours. This ensured a new segment was cast each day in each form.

The Earnest F. Lyons Bridge was completed within budget and eight months ahead of schedule. Photo: Jim Schneidermann, PCL.

A top-down method was used to erect the segments due to shallow water depth and strict environmental-permit restrictions for protected seagrass. Components could be delivered only between 9 p.m. and 5 a.m., which allowed about six segments to be trucked in each night. An on-site staging area stored the segments for one complete span, which was erected after all segments for the complete span were delivered.

The self-launching underslung truss worked with a specialized segment lifter to allow crews to consistently erect one span every four shifts. This process, combined with the focus on casting speed and systematic delivery and staging processes, allowed the project to be completed within budget and eight months ahead of schedule.

Route 36 Highlands Bridge

New Jersey's second precast concrete segmental bridge was designed as a total precast concrete project from top to bottom. The goal was to leverage precast concrete's capabilities for early manufacture to reduce construction time on the bridge. It needed to be brought back into service quickly to provide access to key tourist areas around the towns of Sea Bright Borough and Sandy Hook, N.J.

The schedule required the actual bridge construction to be completed in two construction seasons to minimize disruptions between Memorial Day and Labor Day. In the first season, the eastbound bridge was completed, and all traffic was moved onto the new structure. The existing bridge was then demolished to make room for the westbound structure, which was completed in the following construction season.

The nine-span, twin bridges, built with superstructures of precast concrete segments, feature main spans of about 232 ft. Each structure is nearly 1611 ft long with a deck width of about 46 ft. Features that especially aided the ABC approach were the precast concrete footings, piers, and segmental superstructure.

Precast concrete footings, piers, and superstructure segments were used to accelerate construction on the Route 36 Highlands Bridge. Photo: J. H. Reid General Contractor, Unistress Corporation, or DYWIDAG-Systems International USA Inc.

The water-borne footings consist of 12 precast concrete cofferdams, which were cast on the mainland with an architectural finish on their exterior faces. The footings were floated out for placement and suspended on frames in place. The piles were driven through the openings in the soffit of the precast concrete box, after which the boxes were sealed, dewatered, and filled with concrete to create the bridge footings.

Precast concrete pier columns likewise were cast and barged into position. In all, the 18 piers, which varied in height between 12 and 59 ft, required 98 precast concrete segments to construct.

Heavy reinforcement and post-tensioning for these precast concrete components added complexity to the fabrication of the segments. But the column segments for each pier were typically quickly stacked upon arrival, and then post-tensioned with as many as eight U-tendons and grouted over the next several days. The superstructure consists of 384 precast concrete segments that were combined to create 90- to 240-ft-long spans as needed. The contractor used a barge-mounted crane to erect the column and girder segments. The project ultimately met its schedule commitments and provided a durable design that offers aesthetic enhancements to match the surroundings.

St. Anthony Falls Bridge

A high-profile bridge that was completed under intense pressure for early completion, the St. Anthony Falls (I-35W) Bridge spans the Mississippi River in Minneapolis, Minn. The 1219-ft-long twin structures feature 504-ft-long main spans along with three other spans of 219 ft on one side, and 248 and 148 ft on the other.

The sweeping superstructure has an arching parabolic curve, which varies in depth from 25 to 11 ft and seamlessly connects to 70-ft-tall piers. The main span was constructed with precast concrete segments from four on-site, long-line casting beds.

While the precast concrete segments were being cast, the side spans over land were being cast-in-place on falsework. After their completion, the 120 main span segments were erected in only 47 days.

Officials at the Minnesota Department of Transportation (MnDOT) selected the design-build process, as it offered faster project speed, design flexibility, and construction adaptations. The team selected from among seven potential bridge types, proposed geometric solutions, and developed the visual imagery.

The design-build process was expedited so that construction could begin prior to the winter season. Typically, the procurement timeline takes six to twelve months, but this one took only 50 days. Achieving this speed required daily meetings that allowed the design-team to stay up to date on scope changes and get answers immediately.

MnDOT worked closely with regulatory agencies, utilities, and other stakeholders during the procurement process, obtaining all eight of the possible permits prior to letting. They also held public advisory meetings as design work progressed to speed the schedule. Design flexibility was emphasized to ensure any public concerns could be incorporated into the final design.

The 120 segments in the main span of the St. Anthony Falls Bridge were erected in 47 days. Photo: ©FIGG.

MnDOT offered a $7-million incentive if the project was completed on time by the end of the next construction season, and it included early-completion incentives up to $20 million more if the project was completed 100 days early. The incentives were based on the calculated user costs from having this key bridge out of use.

The bridge opened more than two months ahead of schedule, less than 13 months after the notice to proceed. The design-build process and segmental construction not only brought the bridge into service quickly, but it provided a signature design that will be a proud addition to the community for decades to come.

This is one of a series of articles examining different approaches to accelerated bridge construction and examples featuring those techniques. Details of these projects can be found in the issue archive at www.aspirebridge.org as follows: Earnest F. Lyons Bridge (Winter 2008), Route 36 Highlands Bridge (Summer 2010), and the I-35 W St. Anthony Falls Bridge (Winter and Fall 2008).

For additional photographs or information on this or other projects, visit www.aspirebridge.org and open Current Issue.