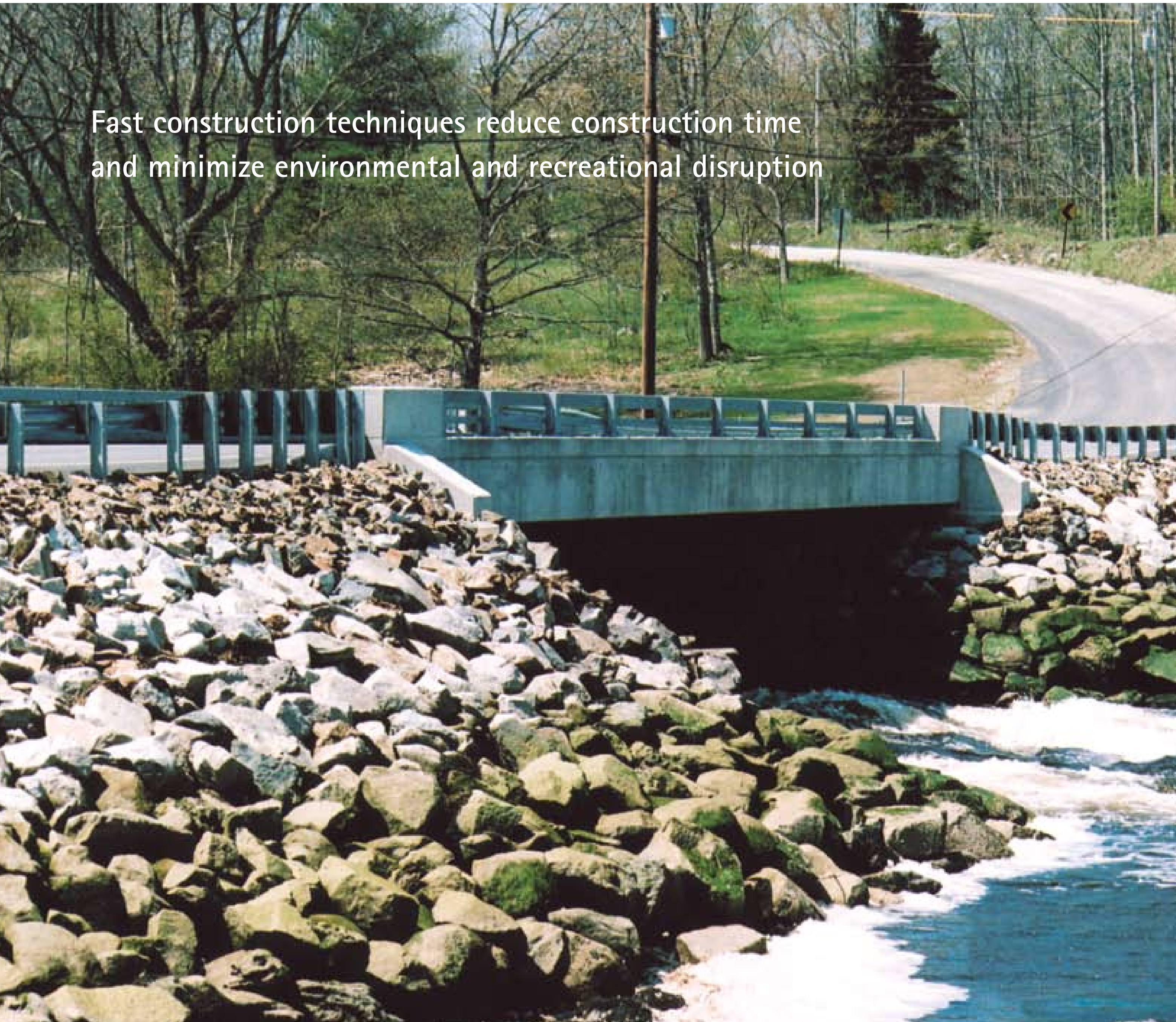
PRECAST CONCRETE BRIDGE



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DAVIS NARROWS BRIDGE / ACROSS THE BAGADUCE RIVER, BROOKSVILLE, MAINE

ENGINEER Maine DOT

PRIME CONTRACTOR Reed & Reed Inc., Woolwich, Maine

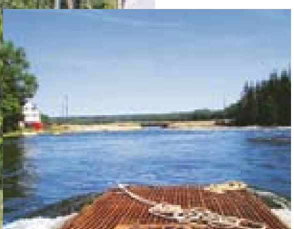
PRECASTER Strescon Limited, Saint John, New Brunswick, Canada

AWARDS *2006 PCI Bridge Design Award for the Best Bridge with Spans Between 65 Feet and 135 Feet and the 2006 PCI All-Precast Solution*

COMPLETED IN 30 DAYS

by Craig A. Shutt

The new totally precast concrete bridge features abutments placed behind the existing ones to maintain the constriction on the flow of water.



Complications arose in the design of the new Davis Narrows Bridge in Brooksville, Maine, because of sensitive environmental issues and the community's desire not to lose its rapids.

Designers looking to replace a deteriorated 90-ft-long bridge in Brooksville, Maine, faced several key challenges. The principal challenge was to minimize closure time due to the long detour required, while meeting a variety of unique community needs. A totally precast concrete bridge system met all of these needs and allowed the bridge to open only 30 days after closure.

The existing bridge had been built in 1941 using painted rolled steel beams on dry-laid granite blocks. Corrosion made it a prime candidate for replacement, but the community was concerned that the new bridge would disrupt the existing structure's "recreational value" and the sensitive river environment.

"The causeways created a constriction of the daily tide that produced rapids between high and low tide," explains M. Asif Iqbal, project manager with the Maine Department of Transportation. "This phenomenon has added entertainment and recreational value on which many tourists and locals depend for riding kayaks and inflatables during the summer. As a result, the locals didn't want any change to the hydraulic characteristics."

The river also is one of the few areas where Horseshoe crabs breed and is a natural fishing ground for local people and wildlife. Oyster farmers downstream also were concerned that silt and sediments from construction would disrupt their livelihood. Those factors, plus tourism in the area that would be disrupted by a bridge closure, created scheduling restrictions that complicated the design.

Design Minimizes Disruptions

"We decided early on that a totally precast, prefabricated system would considerably reduce construction time and the impact on the local residents and wildlife," says Iqbal. Using precast components fabricated in an off-site plant significantly reduced equipment movement, excavation, and flow of any concrete into the tidal area, he notes. The precast abutments also eliminated

PRECAST, PRESTRESSED CONCRETE / MAINE DOT, OWNER

BRIDGE DESCRIPTION A 90.5-ft-long single span bridge constructed with a totally precast concrete system

STRUCTURAL COMPONENTS Four precast abutments, two at each end; four wing walls, two at each end; four precast concrete approach slabs, two at each end; and eight precast, prestressed concrete box beams, BII-48 (89 ft long, 4 ft wide, and 3 ft deep)

BRIDGE CONSTRUCTION COST $1.06 million

Precast components significantly reduced equipment movement and excavation, limiting debris in the tidal area.

the need for cofferdams, which would have disturbed the river sediments. "The use of silt booms at both abutments was all that was needed with precast units."

The precast concrete units also helped minimize closure time. The bridge was designed according to the AASHTO LRFD Bridge Design Specifications. The design took place during the winter of 2005 and a contract awarded in July 2005. The construction team then worked out the sequencing to ensure the fastest possible return to service. They decided to construct the new causeways leading to the bridge first, and then close the bridge to complete the project.

To minimize impact to the existing flow characteristics, the new approach roads on the causeways were built on choke-stone layers stabilized with geotextiles. This took three weeks, after which the bridge was closed on September 6, 2005. It opened to traffic again just 30 days later on October 5.

The new integral abutments were designed to sit 12 ft behind the existing abutments, to ensure the river hydraulics remained the same. The new integral abutments are supported on four piles, which were driven to bedrock. The abutments consist of two precast center units and two precast extended wing-wall units. The units were post-tensioned together with six threaded bars. Voids were designed into the abutment units to receive the piles and were enlarged to decrease shipping weight.

Once the abutments were in place and the post-tensioning was complete, the voids were filled with self-consolidating concrete through the 6-in.-diameter ducts on top of the abutment units. The ducts then were filled with conventional grout. "The use of precast abutments significantly reduced the impact to the river and tidal areas and reduced the construction time by a third," Iqbal says.

The superstructure features eight adjacent precast, prestressed concrete box beams that were post-tensioned transversely to act as a single unit. They were delivered and erected at the rate of three per day. The beams were slid across the river on a launching-girder system and then lifted into place using 110- and 80-ton cranes. The shear keys between the beams were filled with a pea gravel concrete mix. Transverse post-tensioning strands were located at five points along the beams.

Because cracks could have developed in concrete curbs precast on the fascia beams as they were delivered over the rough local roads, cast-in-place curbs were used. The precast approach slabs were erected after the beams and positively connected to the abutments. These slabs support a layer of gravel subbase and prevent settlement of the approaches.

'The four precast units comprising each abutment took only two hours to erect and post-tension.'

Fast Construction During Closure

The first week of closure was spent removing the tops of the existing abutments and excavating the new abutment locations. During the second week, piles were driven and the abutments were erected. "The four precast units comprising each abutment took only two hours to erect and post-tension," Iqbal reports. Grouting was accomplished at low tide.

During the third week, the beams were erected with a crane positioned on either embankment. Work on the curbs started as soon as the first fascia beam was in place. The wing-wall tops were cast early in the fourth week, followed by installation of bridge rail and the application of a high performance membrane. The pavement riding surface was applied during the final two days of closure.

The contract specified a time limit of 35 days for construction, with incentives of $1000 per day for beating that deadline. Equal disincentives also applied. The project was completed five days early. Guard rails were installed during the two days after the bridge opened, but traffic was light and no lane closures were needed, Iqbal reports.

"The use of precast, prestressed concrete beams significantly reduced erection time," Iqbal says. "Substantial time also was saved by not having to construct a deck like the old bridge. We were very pleased with the swiftness with which the contractors could handle the precast units and also the ease of installation."

The project will have ramifications for future designs, because it was only the second bridge in the state to use precast abutments and the only totally precast concrete bridge built over salt water. "The totally precast solution allowed fast construction and promoted low environmental impact because of the ease of construction," Iqbal says.

The community was pleased with the project as well. A group got together to buy drinks for the entire construction crew to celebrate the bridge opening. "This was truly a project that had many issues that needed to be resolved early," says Iqbal. "But they came together with the help of dedicated teams from both the DOT and the contractors, and certainly with the technology of the precast concrete units."

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