PROJECT

Sibley Pond Bridge, Route 2

Design-build bridge replacement project in Maine uses Northeast Extreme Tee

by G. Keith Donington and Hany L. Riad, Parsons Brinckerhoff

The 790-ft-long, two-lane bridge consists of ten 79-ft spans arranged in two 5-span continuous units spanning over a shallow pond. Photo: Lane Construction.

When the Sibley Pond Bridge required replacement, the project team used innovative design and the first use of the Precast/Prestressed Concrete Institute (PCI) Northeast Extreme Tee double-tee (NEXT D) beam section with full-depth integral deck, to open the bridge more than 10 months ahead of schedule. The NEXT D section had been newly developed by PCI Northeast in response to the Federal Highway Administration's (FHWA) nationwide initiative for accelerated bridge construction.

The 790-ft-long, two-lane bridge consists of ten 79-ft-long spans arranged in two 5-span continuous units. The bridge carries U.S. Route 2 between Canaan and Pittsfield, Maine, over a shallow pond. The pond's upper layers of organic material increase in depth towards its middle, and is underlain with glacial till and granite bedrock. Fixity is provided at each end of the bridge through semi-integral abutments. Each of the nine intermediate piers are supported on single rows of four steel-pipe piles that flex as the structure expands and contracts around a single expansion joint located at the center of the bridge.

By limiting cast-in-place concrete construction to the pier diaphragms and 8-in.-wide closure strips between beam flanges, the NEXT D beams were rapidly erected using a gantry crane that rolled sideways from the old bridge and across the new piers. Durability was enhanced by using 8 ksi compressive strength, self-consolidating, precast concrete that included a corrosion inhibitor.

Close collaboration between the contractor, the beam designer, the precaster, and PCI Northeast took place during the project's early stages to optimize the final design details of these new beam sections. This collaboration facilitated maximum efficiencies in precasting, erection by a custom-built gantry crane, and the quality necessary for a 100-year service life as specified by the owner.

Design Considerations

The replacement bridge was placed on a tangent alignment, partially overlapping the existing bridge near the abutments, but with sufficient width to maintain access to the old bridge during construction. The bridge was laid out with 10 equal 79-ft-long spans so that piles from the new bents would be well clear of those from the existing bridge with its 26-ft-long spans.

Early in the proposal phase, the contractor submitted an alternative technical concept to move Route 2 traffic to the south onto an at-grade detour roadway that followed a former alignment of the route. This required a 60-ft-long temporary bridge over the pond inlet. This detour relocated traffic safely away from the work area and enabled the existing bridge to be

profile

SIBLEY POND BRIDGE, ROUTE 2 / CANAAN AND PITTSFIELD, MAINE

BRIDGE DESIGN ENGINEER: Parsons Brinckerhoff Inc., Manchester, N.H., and Boston, Mass.

PRIME CONTRACTOR: The Lane Construction Corp., Bangor, Maine

CONCRETE SUPPLIER: The Lane Construction Corp., Bangor, Maine

PRECASTER: J.P. Carrara and Sons, Middlebury, Vt., a PCI-certified producer used for contractor access, placement of concrete pier caps, and delivery and erection of the NEXT D beams. A detailed structural inspection and analysis was performed for the existing bridge, and several deteriorated existing piles were repaired with reinforced concrete collars, to ensure structural integrity during construction operations.

Beam Selection

The 36-in.-deep NEXT D beams were selected and made continuous for live load by providing continuity reinforcing steel using mechanical couplers over the interior supports. As shown in the typical deck section, the bridge cross section is composed of four 9-ft 4-in.-wide beam units with three 8-in.-wide closures with overlapping headed reinforcement.

Substructure Selection

Each of the nine intermediate concrete pier caps are supported on single rows of four, 24-in.-diameter, concrete-filled steel pipe piles driven to bedrock. The beams are supported on elastomeric bearings, and stainless-steel dowels pin the continuity diaphragms to the pile caps. Each abutment is supported on two rows of steel H piles to provide longitudinal stability.

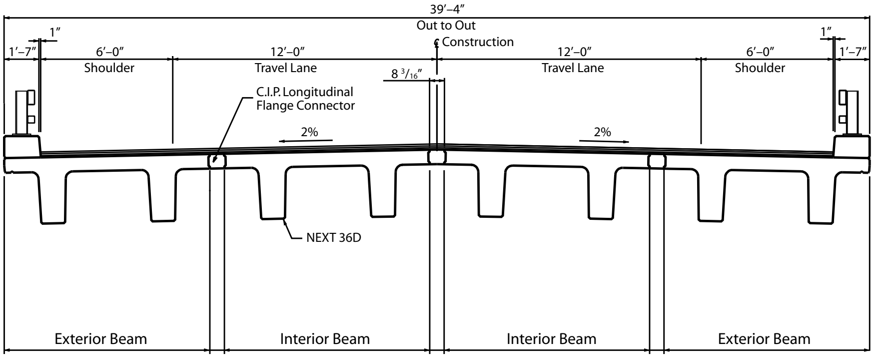
Beam Erection Considerations

Float-mounted erection equipment was not feasible due to the pond's shallow depth. The contractor determined that erecting the beams using a custom fabricated gantry crane was most cost effective. The gantry ran sideways from the old bridge onto the new piers to erect the beams instead of erecting the beams using two cranes supported on temporary pile platforms, as initially indicated during the technical proposal. The steel gantry crane rail support beam system was designed to span from the old bridge to, and along, the new piers. A typical beam erection sequence involved backing the 70-ton beams under the gantry crane.

By using high-performance/high-strength self-consolidating concrete, the precaster was able to consistently achieve an outstanding quality surface finish without any noticeable imperfections. Photo: Parsons Brinckerhoff.

Once the beam was lifted, the truck and beam dolly were removed from the bridge and a steel beam drop-in section was inserted transversely between the gantry legs to complete the beam rails. The gantry crane was then propelled sideways by synchronized electrical winches located at the piers. Spans were erected progressing from the abutments towards the center expansion joint pier for stability.

This erection method proved to be efficient. It took only one day to move the gantry crane from one span to the next. The contractor consistently remained ahead of the crane in setting extra rails, support pedestals, and concrete blocks. After the first spans were erected, the contractor was able to set a span of four beams within an eight-hour shift and achieve an overall turnaround time of two days per span.



The bridge cross section consisted of four 9-ft 4-in.-wide precast concrete NEXT D beam units that were 36 in. deep. The beams were made continuous for live load by providing continuity reinforcing steel over interior supports. Drawing: Parsons Brinckerhoff.

MAINE DEPARTMENT OF TRANSPORTATION, OWNER

BRIDGE DESCRIPTION: 790-ft-long, 36-ft curb-to-curb width, 10-span precast double-tee-beam bridge, constructed as part of a design-build project

STRUCTURAL COMPONENTS: Forty 36-in.-deep NEXT D beams, two cast-in-place abutments supported on HP 14 x 89 piles, and nine cast-in-place pier caps each supported on four, 24-in.-diameter concrete-filled steel pipe piles

BRIDGE CONSTRUCTION COST: $7.7 million

Final Design Innovations

Several innovative details were developed to achieve maximum efficiencies in precasting and erection procedures.

To maximize production of the precaster's form bed to three beams per placement and provide the necessary 15-in. horizontal clearance to accommodate the rails under the legs of the gantry erection crane, it was necessary to keep the ends of the beams free of all mild-steel reinforcement and strand protrusions.

For live load negative moment continuity over the piers, mechanical couplers were detailed to field splice the splice bars between adjacent beams. This required the precaster to align the bars from adjacent beams to tight tolerances. For the positive moment continuity reinforcement in the bottom of the beams, which normally is provided by overlapping extended prestressing strands, a special detail was developed using a steel end plate with field welded ASTM A706 mild-steel reinforcement.

Each of the nine intermediate concrete pier caps are supported on single rows of four 24-in.-diameter, concrete-filled steel pipe piles driven to bedrock. The beams are supported on elastomeric bearings, and stainless steel dowels pin the continuity diaphragms to the pile caps. Each abutment is supported on two rows of steel H piles to provide longitudinal stability. Photo: Parsons Brinckerhoff.

High-performance concrete was used in the longitudinal closure joints. Photo: Parsons Brinckerhoff.

Mechanical couplers were used to connect continuity reinforcement over the interior supports. Photo: Parsons Brinckerhoff.

Durability Considerations

The use of NEXT D beams maximized precast concrete and limited cast-in-place concrete construction in the superstructure to the longitudinal closure joints, the continuity diaphragms at the piers, and the curbs. Long-term durability was enhanced by using high-performance, high-strength, self-consolidating concrete (SCC) with 5.5 gal./yd^3 of calcium nitrite corrosion inhibitors in the precast concrete beams. The precaster consistently achieved 10 ksi compressive strength concrete, although 8 ksi was specified for design. High-performance concrete with calcium nitrite was also specified for all field-placed concrete.

By using SCC, the precaster was able to consistently achieve an outstanding quality surface finish without any noticeable imperfections.

In accordance with the owner's policy, the use of mild-steel reinforcement was specified, with the exception of ASTM A1035 reinforcement for exposed concrete curbs and barrier transitions. Increased cover was necessary to meet the 100-year life requirement.

The roadway deck is protected with a hot machine-applied, high-performance waterproofing membrane system with a 3-in.-thick asphalt wearing surface. The steel pipe piles are protected with a shop-applied, fusion-bonded epoxy coating system extending from the top of the pile to 10 ft below the mud line.

Locating the expansion joint in the middle of the bridge at the crest of the vertical curve had benefits. It resulted in water draining away from the joint in both directions, thereby minimizing the potential for future leakage. The ends of the diaphragms at the joint are covered with a sheet membrane.

Conclusions

This challenging project required close collaboration among several parties to succeed. Excellent teamwork by the owner, contractor, precaster, designer, and PCI Northeast helped make the job a success. Through the use of an innovative beam section, alternative erection scheme, and customized detailing, the team was able to deliver a completed, cost-effective project faster and of higher quality compared to conventional techniques.

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