STATE ROUTE 112 BRIDGE OVER KEARNEY BROOK

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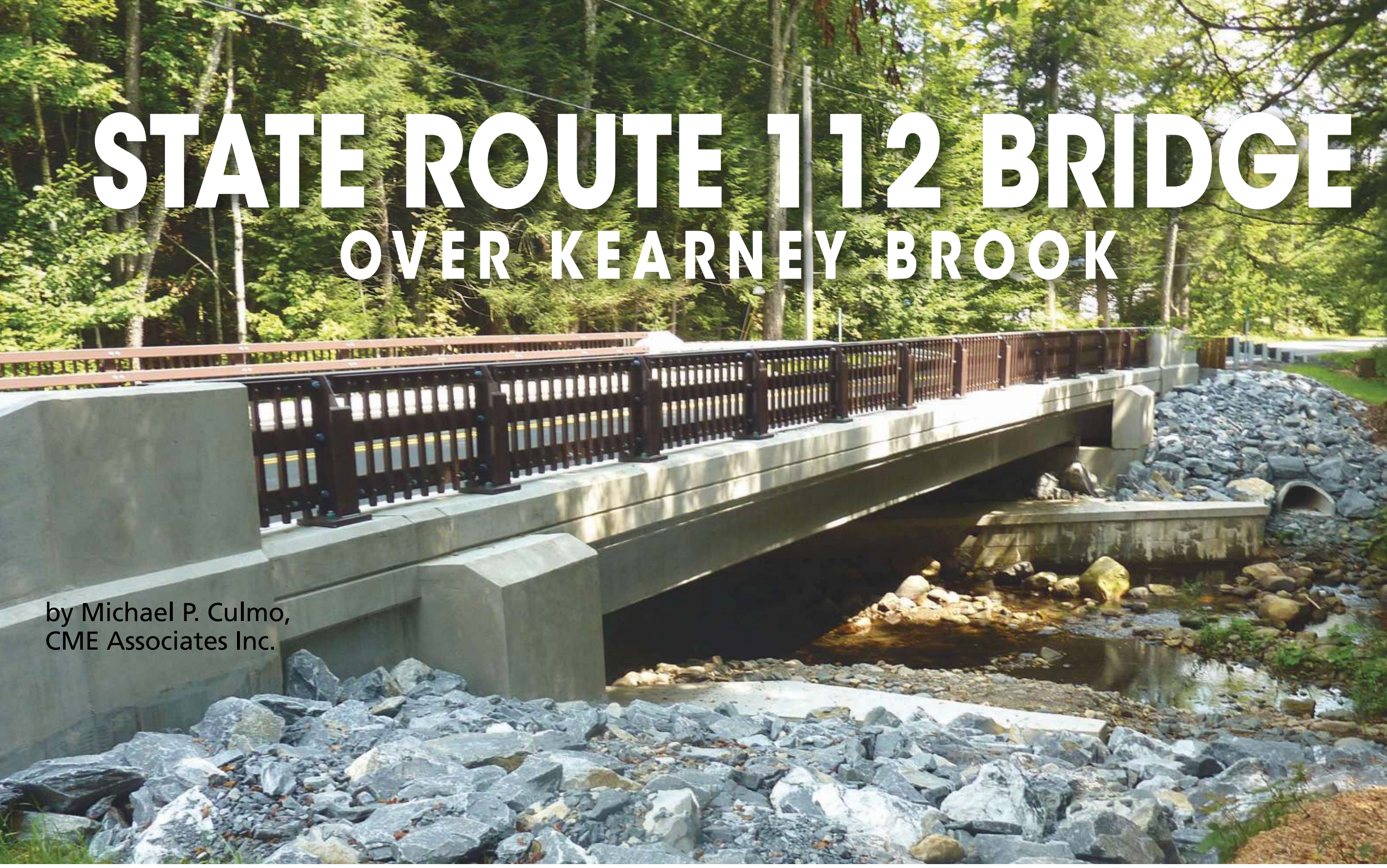

Final configuration of the State Route 112 Bridge over Kearney Brook. Photo: Massachusetts Department of Transportation.

The Massachusetts Department of Transportation (MassDOT) is nearing the completion of an Accelerated Bridge Program (ABP), which has a goal of reducing the number of deficient bridges on an accelerated schedule. The ABP has embraced innovation—especially including the use of accelerated bridge construction (ABC)—in order to deliver projects faster, with better quality, and with less impact to the traveling public and environment. The State Route 112 Bridge that spans over Kearney Brook, in Worthington, Mass., is an excellent example of this use of innovation.

The existing bridge needed to be replaced due to significant deterioration. The original scope of the project was based on using adjacent box beams supported on conventional cast-in-place concrete abutments. Because the roadway crossing the brook is on a horizontal curve, the box beams would need to be chorded on the curve. The plan was to close the roadway during construction. The detour around the site was only 1 mile; however, the impact of the detour on the rural town would be significant because local roads would need to be used.

During preliminary design, MassDOT made a decision to use ABC to reduce mobility impacts. At the same time, the department had adopted a new prestressed concrete beam shape called the Northeast Extreme Tee (NEXT) beam. It is a double-tee beam developed by the PCI Northeast Bridge Technical Committee for intermediate span bridges up to approximately 80 ft long.

NEXT beams were a perfect choice for the for the 62-ft-long, single-span crossing. The design team selected a 32-in.-deep NEXT F (form) beam with a 4-in.-thick top flange used to support an 8-in.-thick composite, cast-in-place concrete deck. Once erected, the flange provides a safe work platform. The specified compressive strength of the concrete for the beams was 8.0 ksi. The forming of the deck is limited to the side and end forms.

Design Challenges

The geometry of the single-span bridge is curved and skewed at 30 degrees, which would put the flexibility of the NEXT beams to the test. The first challenge was the horizontal curvature. The radius of the roadway resulted in a variation of the deck edge of approximately 10 in. when measured from a chord line. The NEXT beams were developed to accommodate this type of curvature. The beams were laid out on tangents, and the curvature was accommodated by varying the width of the fascia beam overhang along the beam length.

MassDOT commonly leaves existing substructures in place to act as scour countermeasures. To accomplish this, the span length was increased to allow for construction of the new abutments behind the existing abutments. This eliminated work in the river channel. The depth to the bedrock was too deep for open excavation and too shallow for an integral abutment, so the design team decided to use a shallow spread footing foundation.

Precast Concrete Details

The design team used precast concrete substructure details that were developed by the PCI Northeast Bridge Technical Committee, including precast concrete spread footings, abutment stems, wingwalls, and approach slabs. Precast concrete footings were placed on temporary leveling bolts and connected to the substrate with a thin layer of flowable fill. The wingwall stems were connected to the footings with grouted splice couplers. The abutment stems were detailed with concrete-filled corrugated steel pipe voids that were connected to the footings via projecting dowels. The height of the stems resulted in only minor moment demand on the connection. The resulting detail was essentially a gravity abutment. Using corrugated pipe voids provided a very durable and inexpensive connection with significant adjustability for tolerances during construction.

Above: Precast concrete footing installation for the State Route 112 Bridge over Kearney Brook. Right: Precast concrete abutment stem installation. Photos: William E. Dailey Precast LLC.

MassDOT has been using unique details for concrete approach slabs for many years. Approach slabs are designed to span over potential settlement areas directly behind abutments. Most agencies detail the approach slabs as a reinforced concrete pavement section. In Massachusetts, the slabs are set slightly below grade (below the pavement structure). This facilitates the installation of precast concrete approach slabs because the grade tolerances can be significantly relaxed while the proper seating of the slab is ensured.

On this project, the precast approach slabs were supported by the abutment stem on one end and by the soil on the other end. The precast concrete slabs were set on temporary supports and then the void under the slabs was filled with flowable fill, which is a cost-effective solution when compared to non-shrink grout. The adjacent approach slabs were connected to one another using a small closure pour with looped reinforcing bars.

The top flange of NEXT beams can be easily adjusted for each project to accommodate various roadway widths. The addition of curvature places an added complexity to the geometry of the bridge. The width of the fascia beam overhang was varied over the length of the beam to form the desired curvature with concave curvature on one side of the bridge and convex curvature on the other.

Construction Schedule and Bid

MassDOT has replaced several bridges in a matter of days using ABC, with both large-scale bridge moves and prefabricated bridge elements. In this case, adding the substructure construction made weekend replacement unfeasible. The NEXT F beams also require a cast-in-place concrete deck, which would need time to cure.

The goal of the schedule was to reduce the duration of the roadway closure and resulting mobility impacts. The design team felt that it was feasible to construct the bridge in as little as 3 weeks; however, construction at that pace can come

Precast concrete approach slab installation for the State Route 112 Bridge over Kearney Brook. Photo: William E. Dailey Precast LLC.

Resiliency

The State Route 112 Bridge over Kearney Brook was designed for seismic loads. Longitudinal forces such as seismic loads were resisted through the use of precast concrete integral backwalls attached to the ends of the NEXT beams. The integral backwalls were cast as secondary concrete placements in the fabrication plant. Longitudinal seismic forces in the superstructure are resisted by the passive earth pressures acting on the integral precast concrete backwalls, thereby reducing the size and cost of substructures.

at a financial cost due to the need for overtime, additional equipment, and the risk of bidding a tight schedule. The project specifications limited work to a normal work week with a single shift. The idea was to build the bridge rapidly, while limiting the pressure on the price and the workers. The final bid schedule was set at 60 calendar days (42 work days), which is much faster than conventional construction.

Very rapid bridge installations can lead to cost increases that can exceed 50%. The goal of this project was to build in a reasonably fast timeframe, balancing construction speed with cost effectiveness. This approach paid off. The bid price for the entire project was approximately $28,000 less than the engineer's estimate.

Construction

Construction followed the anticipated schedule. The old bridge demolition and excavation for the substructures took 7 days. Installation of precast concrete elements took 16 days, and deck casting and railings took 21 days (including curing time for the deck). Approach work and site clean-up filled the remainder of the 60-day schedule. One of the most time consuming portions of the work was the partial removal and capping of the existing abutments.

There is a misconception that ABC is only for large projects and large contractors. For the Worthington project, the exact opposite was the case. A local contractor performed the work. The use of precast concrete elements for large portions of the bridge requires little labor and equipment on site. There is very little formwork that needs to be placed and removed. During most of the construction, there were only a handful of workers on site. The only task that required more labor was the casting of the deck on top of the NEXT beams. Even with this task, there was minimal need for forming, which reduced on-site labor.

State Route 112 Bridge over Kearney Brook. Photo: Massachusetts Department of Transportation.

Northeast Extreme Tee (NEXT) beam installation showing the curvature of the flange. Photo: CME Associates Inc.

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Conclusion

The State Route 112 Bridge over Kearney Brook in Worthington is an excellent example of how precast concrete elements can be used to accelerate bridge construction, even on a bridge with complex geometry. The 62-ft-long, single-span bridge has a 30-degree skew and a curved alignment. Prestressed concrete NEXT beams, with variable top flange widths for the fascia beams, easily accommodated the roadway width, skew, and curvature. The innovative precast concrete gravity abutments proved to be cost effective and easy to construct. Thanks to precast concrete elements and forward-thinking design, the bridge was built rapidly, economically, and with reduced mobility impacts—accomplishing all of the project's goals.

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Team members for the State Route 112 Bridge over Kearney Brook included CME Associates Inc., design engineer, Woodstock, Conn.; J. H. Maxymillian Inc., prime contractor, Pittsfield, Mass; Calderwood Engineering, precast specialty engineer, Richmond, Maine; and William E. Dailey Precast LLC, a PCI-certified precaster, Shaftsbury, Vt.