STATE

Concrete Bridges in

New Hampshire

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Designing and constructing economical and durable highway bridges has always been a challenge for state transportation agencies. Conflicting needs such as system expansion for safety and capacity versus system preservation and maintenance compete for dollars. Shrinking state transportation budgets compound the problems at the same time that increasing numbers of highway users overburden our aging infrastructure. State and federal agencies nationwide have worked individually and collectively to develop design concepts and materials to address these needs. The New Hampshire Department of Transportation (NHDOT) continues to be involved in developing solutions to some of the problems facing the public transportation community in the twenty-first century.

Over the past 15 years or so, many NHDOT bridge projects have built on the success of previous projects and details. Initial efforts concentrated on the development of standards for high performance concrete (HPC) for bridge decks. In turn, this technology was applied to other structural elements. Through support from PCI Northeast (PCINE), the New England bulb-tee (NEBT) girder utilizing HPC was developed as an economical standard precast, prestressed concrete bridge member. Details were developed for partial- and full-depth precast, prestressed concrete deck panels that also utilized HPC, again learning from previous successes and challenges. This article presents several of the many NHDOT bridge projects that make use of proven HPC and precast, prestressed concrete technologies. Although comparatively small in scope, these projects demonstrate the effectiveness, efficiency, and economy of precast concrete systems and details for bridge rehabilitation and construction.

Completed Bristol Bridge carrying NH 3A over the Newfound River used partial-depth deck panels.

Bristol – NH Route 104 over Newfound River

Built in 1995, this 65-ft-long single-span bridge was NHDOT's first use of HPC. The five AASHTO Type III girders were spaced at 12 ft 6 in. and used a specified compressive strength of 8000 psi at 28 days. This was the highest ever specified in a NHDOT design. The wide girder spacing necessitated an HPC deck with a specified 28-day strength of 6000 psi, which is significantly higher than NHDOT's typical 4000 psi deck concrete. The selected deck mix design was based on research performed by the University of New Hampshire. This research involved casting deck slabs from three unique concrete mixes and then subjecting those slabs to truck loading at the entrance to a landfill.

Bristol – NH Route 3A over Newfound River

Based on the success of the first Bristol project, NHDOT constructed a second HPC project in 1999. This project utilized four NEBT girders spaced at 11 ft 6 in. to achieve the 60-ft-long span. To avoid the expensive deck falsework prices of the first project, partial-depth precast deck panels were used. These were then topped with an HPC concrete overlay.

Rollinsford – Rollins Road over Main Street and B&M Railroad

The existing four-span bridge, constructed in 1938, was built with steel beams and concrete deck and had a total length of 168 ft. The new bridge, built in 2000, was constructed using NEBTs with a single 110 ft span over the railroad and roadway. Five girders, spaced at 7 ft 5 in. on-center, were used to construct the bridge. This project is especially noteworthy because the deck reinforcement for the cast-in-place deck was a non-corrosive carbon fiber reinforced polymer (CFRP) grid, 9 ft wide by 7 ft long. Individual grid elements were sized to replicate the ultimate strength of Grade 70, No. 6 reinforcement, and used a similar spacing as conventional deck reinforcement. Since each grid is light enough to be carried by an individual worker, placement was easier and faster than that of conventional steel reinforcement. The deck contains numerous fiber optic strain gauges for performance evaluation and continues to be monitored by the University of New Hampshire.

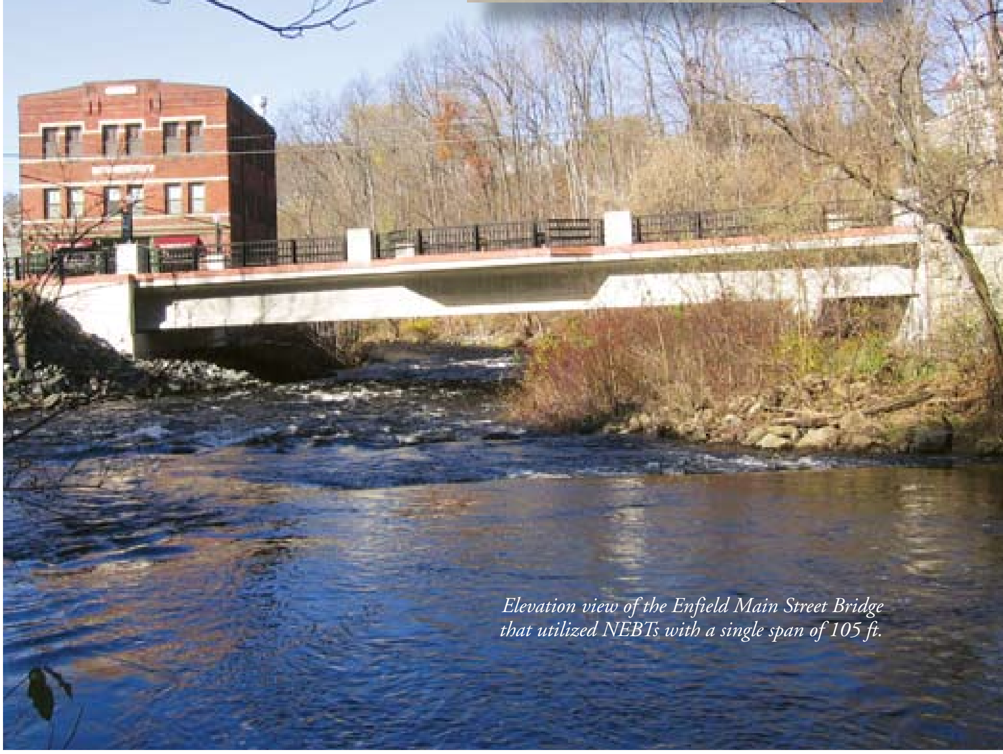
Workers begin installation of CFRP grids in Rollinsford.

Enfield – Women In Service to Enfield (WISE) Main Street Bridge over Mascoma River

The Main Street Bridge over the Mascoma River replaced an existing three-span concrete encased jack-arch girder bridge built in 1916. The original bridge had three equal spans of 34 ft with both piers located in the Mascoma River. The new bridge, constructed in 2002, utilized NEBTs with a simple span of 105 ft. Five girders support the cast-in-place concrete deck with 11 ft 4 in. typical lane widths plus 5-ft 6-in.-wide sidewalks. The upstream sidewalk included a "bump out" at midspan for use by fishermen and those viewing this scenic portion of the river and adjacent mill area. Both sidewalks specified red-colored concrete with an embossed brick pattern to replicate the brick sidewalks constructed on the bridge approaches.

The NEBTs were 72 in. deep using both straight and harped prestressing strands. NHDOT typically designs for zero tensile stress in the precompressed tensile zone of prestressed concrete girders. With an 8-ft 10-in.-girder spacing, the required concrete strengths for the girders were 5800 psi at release and 8000 psi at 28 days. The result was a very economical structure that eliminated the pier obstructions from the river and provided an attractive crossing for both vehicles and pedestrians.

Completed Main Street Bridge with historic mill in the background.



Elevation view of the Enfield Main Street Bridge that utilized NEBTs with a single span of 105 ft.

Placement of the first precast footing segment in NHDOT's first entirely precast bridge in Epping.

Eight days after the first precast footing piece was placed, the Mill Street Bridge in Epping was paved and opened to traffic.

Epping – Mill Street Bridge over Lamprey River

NHDOT constructed this bridge using totally precast substructure and superstructure components. The existing crossing was comprised of two simple spans each 30-ft-long and separated by a 60-ft-long pier/island. It was replaced with a 115-ft-long simple span consisting of 3-ft 0-in.-deep box beams, transversely post-tensioned.

The NHDOT used this bridge as a pilot project to see how fast a totally precast bridge could be constructed, once site preparation had been completed. With the town allowing the road to be closed during site preparation and construction (a short detour was available), the Mill Street site was well suited for this experiment. Months of design and planning went into the project before any construction began. Site preparation work, including lowering of the pier/island, took approximately 2 months. Once the first precast footing piece was placed on the prepared subfooting surface, the contractor was allowed 14 days before opening the bridge to traffic. With an assembly plan in place that detailed the contractor's entire proposed work, including contingency plans addressing any changes to the work (for example: equipment breaking down), the contractor completed the bridge construction in only 8 days. An incentive/disincentive clause was included to either reward or penalize the contractor so they would adhere to the specified 14-day time frame.

Due to the success of this project, precast details from this project have been incorporated into PCINE's *Guidelines for Accelerated Bridge Construction Using Precast/Prestressed Concrete Components* (available for download at http://www.pcine.org/view_file.cfm?dir=\resources\design_tools\165\&filename=Accelerated_Bridge_Guidelines.pdf).

NHDOT's first use of precast, prestressed full-depth deck panels on the redecking of the Mosquito Bridge over Lake Winnisquam.

Sanbornton & Belmont – NH Route 3 (Mosquito Bridge) over Lake Winnisquam

NHDOT's first use of full-depth deck panels for the replacement of the deck was on this bridge. NHDOT has used partial-depth deck panels since the early 1990s and with FHWA's Innovative Bridge Research and Deployment (IBRD) funds, decided to experiment with full-depth deck panels.

The four-span bridge, with exterior spans of 104 ft 0 in. and interior spans of 130 ft 0 in., has a 53 ft 3 in. out-to-out width. A total of one hundred and sixteen 8-in.-thick panels, each 8 ft long, were fabricated for this project. Post-tensioning ducts were incorporated into each panel and spliced together once the panels were set. The post-tensioning strand was placed through the duct, tensioned, and the entire duct grouted. After post-tensioning, shear stud blockouts were also grouted.

Due to traffic phasing, half the panels were 26 ft 4 in. wide and the other half were 25 ft 11 in. wide. This required a closure placement over the middle girder. Unlike a closure between girders, the panels required support from the middle girder while casting the closure and developing reinforcing steel in the negative moment region over the girder. This required a blockout in the panel to splice the reinforcement.

IBRD funds were used on this project to allow for an incentive/disincentive clause to see how fast the contractor could remove and replace the deck using full-depth panels. Learning from the successes and setbacks of this project, the NHDOT has advertised another deck replacement project using full-depth deck panels and has gained more knowledge on their application for future projects.

Summary

The projects described have been very successful and have provided significant information and experience on which future projects can be developed. As more details become standardized and as more contractors in the northeast region gain experience with these materials and techniques, the cost and required construction time should be reduced. Although not suitable for every site or for every bridge application, precast bridge elements have clearly demonstrated their effectiveness in addressing the concerns of state transportation agencies—namely, by providing efficient and durable bridge elements that can be quickly and easily installed at an economical price to provide low maintenance bridge structures. When considering the overall deteriorated condition of the nation's transportation infrastructure, these advances in bridge technology and construction will provide safe and effective project delivery for the traveling public. NHDOT is pleased to be a part of that effort and to contribute toward that goal.

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For more information on New Hampshire bridges, visit www.nh.gov/dot/index.htm