

The DCR Access Road Bridge over Route 24

Winner of 2011 PCI Design Award and Voted “Best Non-highway Bridge” by Aspire Magazine

By Matt Card and Thomas Cyran



The new precast concrete channel bridge (bottom photo) and the original steel I-girder bridge (top photo) and are shown for comparison. The new channel bridge provides nearly 2 ft of additional clearance over the original bridge without increasing the roadway profile on the bridge.

This project involved the replacement of Bridge R-01-012 which carries the Department of Conservation and Recreation (DCR) Access Road over Route 24 in the Town of Randolph, Massachusetts. The access road connects two large parcel of park land within Blue Hill Reservation that is divided by Route 24. The bridge is primarily used by recreational hikers, horseback traffic and DCR maintenance vehicles. This bridge reconstruction project was administered by the MassDOT – Highway Division and was completed in the Fall of 2010 at a cost of \$3.9 million.

Randolph, Massachusetts is located 15 miles south of Boston. The town was originally called Cochaticquom by the Cochato and Ponkapoaq tribes. The town was renamed after Peyton Randolph, first president of the Continental Congress.

The original bridge, built in 1958, consisted of a 247-ft-long, four-span steel I-girder bridge supporting a 7.5-in concrete deck slab and asphalt wearing surface. The substructure featured two concrete stub-type abutments supported on steel piles and three reinforced-concrete piers supported on spread footings.

Partly due to its low 13'-9" vertical clearance over Route 24, the existing bridge had become structurally deficient. In fact, the steel I-girders had repeatedly been hit by trucks driving below on Route 24 and had been torn through in numerous areas due to hit damage. Officials at the MassDOT – Highway Division wanted to increase the vertical clearance without having to perform extensive roadway work either underneath the bridge or at the access road approaches. Raising the profile of the approach

roads beyond the abutments was not an option, as they transition to heavily wood areas and hiking trails within the park. The hiking trails were also used as horse paths that accommodate horse-rental farms nearby. MassDOT officials also wanted to create a design that would blend with the scenic surroundings, minimize disturbance to the surrounding woodlands and minimize long-term maintenance needs.



The I-girders of the original steel bridge were removed and then reused as temporary erection beams to support the precast concrete channel segments during erection.

To reach those goals, MassDOT engineers selected the precast concrete “channel” bridge concept with post-tensioned, segmental construction. In addition to meeting the immediate goals, the new bridge provides long-term durability through a minimum service life of 75 years. The channel cross-section features a precast concrete superstructure with an unusual U-shaped design that provides a very shallow structure depth (12”) from the bridge deck and it’s underside. The section consists of two edge beams that function as the main load-carrying elements,

with the roadway slab supported between them. The two edge beams serve the dual purpose of acting as bridge parapets as well.

The new DCR Bridge is a 248-ft-long, two-span continuous precast segmental concrete structure that increases the vertical clearance over Route 24 to 16’5”, adding more than 2 ft. to the clearance provided by the previous steel stringer bridge. The substructure consists of two new reinforced concrete stub-type abutments supported on steel piles and a new center pier consisting of two 59-in.-diameter reinforced-concrete columns supported on a common concrete spread footing. Utilizing only

a center pier, the DCR Bridge eliminates the need for side piers along the edge of the northbound and southbound roadways. This provides added safety for highway users, and also reduces material cost and construction time.

The new superstructure is 29.7 ft wide and 5.38 ft deep. The precast concrete edge beams are fully post-tensioned using a mix of 12-, 15-, and 19-strand tendons. Additional longitudinal tendons are provided in the deck slab, using flat 4-strand tendons. Transversely, the structure is fully post-tensioned using flat 4-strand tendons. All reinforcing steel consists of epoxy-coated bar.

Alfred Benesch & Company (formerly Purcell Associates) served as the Engineer of Record on the project and designed the substructure elements. The firm subcontracted the superstructure design to International Bridge Technologies (IBT), which has experience with the channel concept. It was originally created and patented by the innovative bridge engineer Jean Muller, whose firm designed two such bridges in upstate New York in the 1990s and others in Europe. Daniel Tassin, IBT's chief technical director, worked with Muller for many years.

Unistress Corp. served as the precaster for the project. They purchased forms that were specifically designed for the channel cross section and then shipped them to their precast yard, for assembly and casting. R. Zoppo Corp. served as general contractor, with Finley Engineering Group Inc. performing construction-engineering services.

Minimizing waste and remaining environmentally aware were project goals and resulted in an innovative reuse of materials. The steel I-girders of the existing bridge were re-used to fabricate erection beams, thus serving as the temporary shoring needed while the segments were being erected. Upon completion of segment erection and subsequent grouting and post-tensioning, the steel I-girders were removed and recycled for reuse. The existing bridge piles were retained where possible and supplemented with new ones set between the existing ones. To minimize excavation needs along the highway, the center pier's footing was retained. The contractor removed the existing material to the top of footing and simply poured the new concrete on top of the existing footing.

A total of 31 precast concrete channel segments were cast for the project. Typical segments were 8.2-ft long, with the abutment segments being 5.1-ft long. In order to avoid deflection issues resulting from unequal weight distribution, all of the segments were placed onto the erection beams prior to their actual

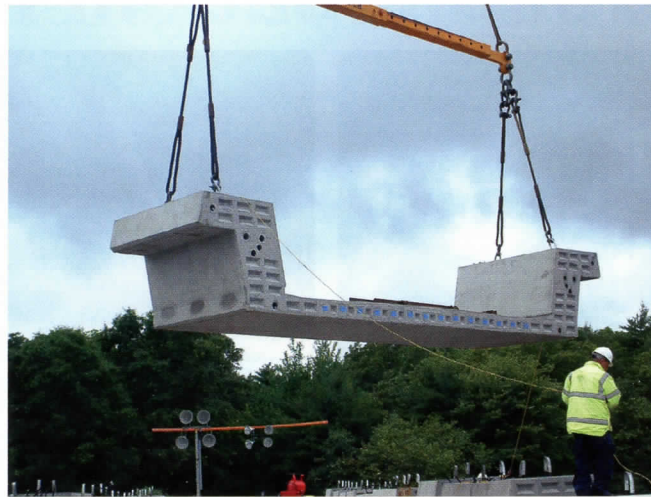
assembly. Then, groups of 2 to 4 segments were assembled together incrementally using post-tensioning bars, starting from the center of the bridge and moving towards the abutments in a balanced sequence. Each group of segments was assembled in a one-day shift. Once all of the segments were assembled

together, the permanent post-tensioning was stressed in the edge beams and deck slab, and the temporary steel shoring was removed.

When the erection of the superstructure segments was completed, the contractor finished casting the abutment backwalls and the top of wingwalls and added the asphalt riding surface. The bridge's channel shape provides a 4-ft-high concrete parapet railing along both sides of the bridge, to which a Type II Modified Protective Screen was mounted on each of the parapets.

Timber guard railing and posts were added within the project limits at all four corners of the bridge for traffic safety. The guardrail has a special steel backing for added strength and safety.

Owners, contractors and engineers are constantly looking for ways to build structures that provide longer durability, a faster



The 8.2-ft-long U-shaped segments feature a flange on the top of both sides that temporarily supported the precast segments on steel erection beams.



Underside view of completed bridge.

speed of construction and pleasing aesthetics. The channel design provides a new alternative for achieving these goals. The channel design provides a sleek, low-profile appearance that provides functional clearance benefits while keeping it unobtrusive in scenic areas. Best of all, it minimizes long-term maintenance needs that will improve safety of construction crews and users while reducing costs over its service life. **PE**

Matt Card is a Project Manager at Alfred Benesch & Company in Boston, and Thomas Cyran is a Bridge Engineer with International Bridge Technologies in San Diego.