Willow Street Bridge

by Matt Hopkinson, Massachusetts Department of Transportation

The completed Willow Street Bridge. Photo: John Phelan.

Installation of the precast concrete arches for the Willow Street Bridge. Photo: Matt Hopkinson.

Originally built in 1847, the Willow Street Bridge is a two-lane structure that spans over the Charles River between Needham and Dover in Massachusetts. The bridge is well-traveled—by cars and bikes alike—and contributes to the area's historic charm. Reconstructed in 1930, the superstructure consisted of a single-span, reinforced-concrete spandrel arch supporting earthen fill and a bituminous concrete wearing surface. The foundation was composed of two concrete abutments with U-shaped wingwalls, with a stone façade, including some original materials considered historic.

By the early 2000s, the condition of the bridge had deteriorated enough to warrant replacement of some of the bridge's components. The replacement structure was initially scheduled to be a reinforced cast-in-place concrete arch and wingwalls. However, after assessing the impact this approach would have on local traffic, as well as environmental concerns for construction in water, the project team decided on an accelerated bridge construction (ABC) approach using a precast concrete arch and wingwalls.

Because the historic stone façade was so important to the community character, the precast concrete structure was designed to closely match the appearance and geometry of the original bridge above the waterline but differed somewhat beneath. The design incorporated as much of the existing stone facing as possible, which was mapped by the contractor before demolition so that it could be replicated during construction. In addition, a crash-rated CP-PL2 barrier, with the addition of stone facing from the existing arch and with new stone facing similar to the existing one as needed, was placed on the bridge and extended out on all four quadrants.

The original, single-span, reinforced concrete spandrel arch Willow Street Bridge. Photo: Matt Hopkinson.

Ten precast concrete arch sections were used to make the 55 ft 6 in. span with a 9 ft 2½ in. rise. The width of the sections varied between 3 and 4 ft. Each arch section was a single piece and was delivered on a special extendable trailer. The arch sections were grouted at the ends and longitudinal joints were sealed with a bituminous layer. Backfill was placed in 8 in. lifts, with a maximum of 2 ft differential fill between each end of the span.

Each piece had four lift points, the lowermost being used later for weep holes. Each of two cables were attached at two of the points, forming two inverted vees, with pulleys at the top to equalize the load. The two exterior units had a portion of the spandrel wall cast into them. When lifted by the crane, these two units were found to be top heavy and could not be lifted into their proper position. Some quick calculations indicated that the unit could be lifted by the two uppermost lift points without undue stress and the erection proceeded on schedule.

Construction began in late 2010 and was completed in the fall of 2012. The bridge was closed entirely, so crews completed the new construction on site, moving the precast concrete arch sections and spandrels. Using the precast concrete structure resulted in a much faster construction time.

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