

## **WASHINGTON STREET (ROUTE 85) OVER THE ASSABET RIVER BRIDGE REPLACEMENT IN HUDSON, MA**

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### **INTRODUCTION**

Working closely with the Massachusetts Department of Transportation – Highway Division (MassDOT), the Town of Hudson, and local businesses, Jacobs Engineering Group utilized innovative construction methods and materials including UHPC to help minimize impacts to the local community and successfully deliver a completed bridge within the required time constraints.

The existing bridge carrying Washington Street (Rte. 85) over the Assabet River, which consisted of a deteriorated three-span, masonry arch structure, is a vital link to downtown Hudson, Massachusetts. Washington Street is the primary north-south route through the commercial center of Hudson carrying 21,000 vehicles per day. The bridge was replaced with NEXT-40D beams supported on concrete abutment pile caps and micropiles. The new bridge design and construction had many challenges including complex phased relocations of utilities with utilities located in six of the seven bays, limited space for staging construction equipment and materials due to commercial properties abutting each corner of the bridge, limitations for crane placement and movement, and below-grade obstructions.

### **ACCELERATED BRIDGE TECHNIQUES**

During the design phase, Jacobs estimated the duration of the construction tasks and durations required to demolish the existing bridge and construct the new bridge. After extensive coordination with the local community and the Town of Hudson, the full bridge closure duration was limited to 105 days, which included demolition of the existing bridge. To meet this construction duration, Jacobs employed several accelerated bridge techniques which included:

- Prefabricated substructure elements and High-Early Strength Concrete
- Precast Northeast Extreme Tee D (NEXT-D) beams
- Ultra-High Performance Concrete (UHPC)

### **Prefabricated Substructure Components**

The bridge design included precast backwall and abutment pile caps to expedite substructure installation. The design specified embedded corrugated metal pipes (CMPs) at locations of the proposed piles. High-early strength concrete achieving 3,000 psi strength in 36 hours was required in the CMP voids. The contractor, New England Infrastructure, provided an alternative by using conventional cast-in-place construction combined with installation and testing of the piles prior to the full bridge closure. The elimination of the pile installation and testing from the full bridge closure construction window allowed the contractor to use a lengthier process of casting and curing the abutment caps and backwalls on site. The micropile installations required partial road closures and the piles were installed and tested during off-peak and nighttime hours. Once the bridge was closed, the contractor excavated the soil and cut the piles at the required elevations.

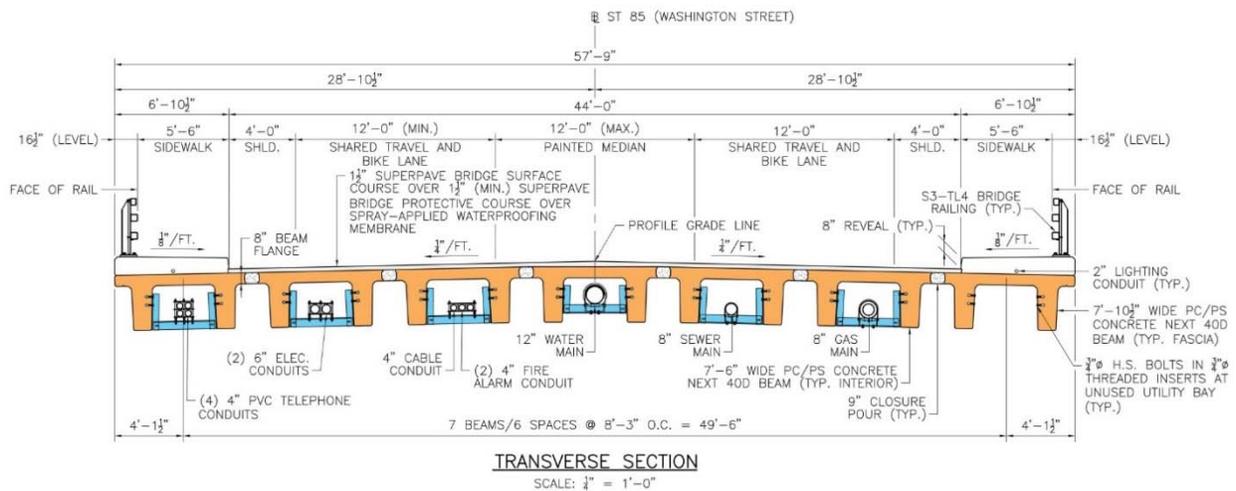
Precast substructure approach slabs and closure panels at the ends of abutments were also used to expedite construction. Closure walls at the ends of the abutment pile cap were specified to align with the existing canal walls on each side of the bridge. The closure walls were designed to facilitate permanent

relocation of Verizon fiber cables. Prior to the full bridge closure, utilities crossing the bridge were relocated to a temporary utility bridge constructed on the west side of the existing bridge. The closure walls consisted of top and bottom precast panels. The bottom panel was installed with the abutment pile caps and the upper panel was not installed until the Verizon cables were shifted from the temporary utility bridge to the new abutment backwalls during the full bridge closure. All other permanent utility relocations were made after the bridge was re-opened to traffic.

### Precast Northeast Extreme Tee D (NEXT-D) Beams

The NEXT-D beams are constructed with 8-inch thick flanges, which serve as the roadway deck (see **Figure 1** for the bridge transverse section). This reduced overall construction duration by eliminating the need for a typical cast-in-place concrete roadway deck. The NEXT-D beam shape also provided the opportunity to pre-install the new utilities between the stems of the members at the pre-caster's facility, greatly expediting the utility relocation. NEXT-D beams offered other benefits, including no requirements for painting and minimal future maintenance.

The proposed bridge geometry limited the width of the new beams, and the 85-foot spans were at the upper limits of the NEXT-D capacity. To meet the AASHTO and MassDOT prestressed beam design requirements, a concrete compressive strength of 10,000 psi was required. Although used in neighboring states, this was MassDOT's first use of 10,000 psi concrete mix for precast concrete beams.



**Figure 1. New Bridge Cross-Section**

### Ultra-High Performance Concrete (UHPC)

The bridge geometry necessitated the use of narrow cast-in-place concrete closure pours between the adjacent beam flanges. Due to the reduced closure pour widths and to achieve high strength rapidly, Jacobs and MassDOT elected to use Ultra-High Performance Concrete (UHPC) for the closure pours. The Hudson bridge project is one of two projects that used UHPC in Massachusetts as part of the FHWA Every Day Counts – 4 program. During design, extensive coordination was required with MassDOT and LaFarge, the supplier of the Ductal JS1000 Joint Fill, to develop the UHPC specifications. A mock-up of the joint was required to evaluate the bond between the UHPC and the beam flanges, and to closely mimic production placement conditions.

After field-casting the closure pours, the UHPC attained minimum compressive strengths of 11,070 psi within 3 days, and the design compressive strength of 14,000 psi within 7 days. The 28-day compressive strength was 21,580 psi.

## **CONCLUSION**

The existing bridge was demolished, and the new bridge was installed and opened to vehicular and pedestrian traffic in 85 days, 20 days sooner than the pre-negotiated outage length. The existing bridge was demolished in 2 weeks; the substructure was constructed in 3 1/2 weeks; and the superstructure was completed in 6 1/2 weeks. Total construction cost, including approach roadway work, was \$4.7 million.

The project demonstrated that through proper planning and effective use of accelerated bridge construction techniques, the impacts of needed bridge construction can be greatly reduced even on relatively small-scale projects. This project not only solved the critical needs of Hudson and the region ahead of schedule but also proved the efficacy of UHPC application for future bridge projects throughout Massachusetts.

The presentation will discuss Jacobs' experience on the project and the design and construction challenges that were met through the use of NEXT beams, UHPC and prefabricated bridge elements. Careful preparation and coordination were required to make the application of UHPC successful. UHPC and additional construction materials required Jacobs to work closely with the MassDOT Research and Materials Department to develop a new suite of material and construction specifications. Discussion will include how those piloted requirements for the prefabricated bridge elements, UHPC and concrete mixes were developed, evaluated and their final outcome.