PROJECT

Faunce Corner Road Bridge Over Interstate 195

by Paul W. Berthiaume and John F. Watters, GPI

The Massachusetts Department of Transportation (MassDOT) recently completed construction of a two-span bridge that carries Faunce Corner Road over Interstate 195 (I-195) in Dartmouth, Mass., as part of a larger highway and intersection improvement project. This section of Faunce Corner Road is a heavily traveled area, which, prior to the project, had become congested with vehicle queues extending from the I-195 exit ramps back onto the mainline of I-195.

East elevation of completed Faunce Corner Road Bridge Over Interstate 195. All Photos and Figures: GPI.

Background

Constructed in 1966, the existing bridge was a prestressed concrete girder superstructure supported by concrete gravity abutments and multicolumn bent piers. It comprised five simple spans totaling 244 ft and had a curb-to-curb distance of 40 ft with a single 5-ft-wide sidewalk. The bridge superstructure was performing well, but the deck joints had failed and the piers were heavily deteriorated because the pier caps were directly exposed to roadway salts from the failed joints above.

In response to the vehicular demand in the area, a traffic study was carried out, and it indicated that more travel lanes and sidewalks were required across the bridge. A bridge study was performed to determine whether to undergo a bridge rehabilitation or complete replacement. Because the existing bridge superstructure was doing well, a bridge rehabilitation and widening option was strongly considered. However, the study concluded that—because the existing piers were constricting future I-195 expansion and the existing overhead clearance was only 14 ft 5 in.—a complete bridge replacement that improved these deficiencies was a better overall investment for MassDOT.

The bridge study focused primarily on precast, prestressed concrete and steel plate girder solutions because of the anticipated 120-ft span range. The bridge's history showed that precast concrete girders could perform well in the environment, which made it difficult to not be biased toward that solution. There were some initial concerns that the weight of the concrete girders would create large reactions and potentially require large and uneconomical substructure elements. However, this bridge site had the benefit of high bedrock, which allowed the footings to bear either directly on rock or on a lean concrete fill to rock. This fact alleviated concerns about needing large footings or deep foundation elements as the project moved further into the design phase. Based on cost and service-life considerations, the study ultimately concluded that the bridge should be completely replaced and precast, prestressed concrete girders should be used.

Precast, prestressed concrete girders were selected over weathering-steel girders because the project is located within 5 miles of the ocean and in a corrosive environment. However, the use of prestressed concrete girders involved certain design constraints. To reduce the formation of cracks in the girders, the bottom flange was designed to meet MassDOT's most stringent requirements and to have minimal tensile stresses in the precompressed tensile zone under the Service III limit state after prestressing losses have occurred. Reducing the formation of cracks lowers the risk that chloride contamination might reach the

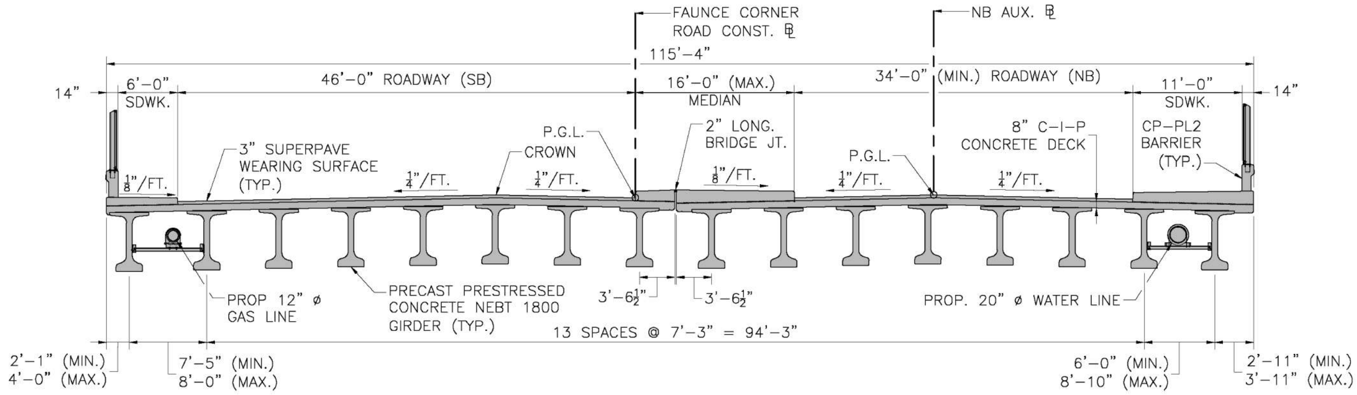
profile

FAUNCE CORNER ROAD BRIDGE OVER INTERSTATE 195 / DARTMOUTH, MASSACHUSETTS

BRIDGE DESIGN ENGINEER: GPI, Wilmington, Mass.

PRIME CONTRACTOR: J.H. Lynch & Sons Inc., Cumberland, R.I.

PRECASTER: J.P. Carrara & Sons Inc., Middlebury, Vt.—a PCI-certified producer



Typical bridge cross section.

prestressing strands and extends the service life of the girders.

Bridge Configuration

The new bridge is composed of Northeast Bulb Tee (NEBT) 1800 (1800-mm-deep [70.9-in.-deep]) precast, prestressed concrete girders with a cast-in-place, 8-in.-thick, reinforced composite concrete bridge deck. The girders are supported by cast-in-place concrete cantilever abutments and a single cast-in-place concrete multi-column pier.

The bridge pier is centered in the median of I-195, and the abutments are located 30 ft back from the edge of the closest lane, which set the spans at 120 ft each. The new bridge has an overall out-to-out width of 115 ft 4 in., with slight variations due to the horizontal roadway alignment. The roadway consists of a 6-ft-wide sidewalk, an 11-ft-wide sidewalk, a variable-width median (16 ft maximum), a 46-ft curb-to-curb width southbound, and a 34-ft (minimum) curb-to-curb width northbound. The bridge also carries a 12-in.-diameter gas line on one exterior bay and a 20-in.-diameter water line on the opposite exterior bay.

Because of the width of the bridge, a longitudinal joint was constructed down the center of the bridge, which essentially created two independent superstructures. To limit thermal movement of a bridge and stress on the bearing assemblies, MassDOT's general policy is to provide a longitudinal bridge joint in the median if the bridge width exceeds 72 ft.

The bridge profile is on a 300-ft-long vertical curve with 2.51% entry and -3.87% exit grades, and the roadway alignment over the bridge is on a 3800-ft-radius horizontal curve. The new design removed multiple piers from the I-195 shoulders, which allows for future expansion and also provides 16 ft 6 in. of minimum vertical overhead clearance for I-195.

The roadway vertical curve crest was located in the second span and required close geometric coordination with the anticipated residual girder camber to lessen the depth of haunches at time of deck placement. This geometric coordination allowed the design to reduce additional haunch dead load and avoided complications of installing variable-depth stirrups to create composite connections with the deck slab. The bridge seat elevations and sole plate slopes had to be determined through computer-aided design modeling to ensure that the final beam would provide full contact to the 24-in.-diameter reinforced elastomeric bearing pads. MassDOT prefers to use elastomeric bearing pads where possible; in this case, they were sized and designed to meet all requirements of the American Association of State Highway and Transportation Officials (AASHTO). The bearing pads were located at both ends of the girders.

With the 120-ft span lengths and an average girder spacing of 7 ft 3 in., NEBT 1800 girders were selected because

Completed stage I bridge in service while stage II is under construction.

MASSACHUSETTS DEPARTMENT OF TRANSPORTATION—HIGHWAY DIVISION, OWNER

BRIDGE DESCRIPTION: A 240-ft-long, two-span continuous for live load, precast, prestressed concrete bulb-tee girder bridge

STRUCTURAL COMPONENTS: Thirty-two (16 per span) precast, prestressed concrete NEBT 1800 girders, 8-in. cast-in-place composite concrete bridge deck, cast-in-place concrete cantilever abutments, and cast-in-place concrete multi-column pier

BRIDGE CONSTRUCTION COST: \$6.35 million bid cost (approximately \$230/ft^2)

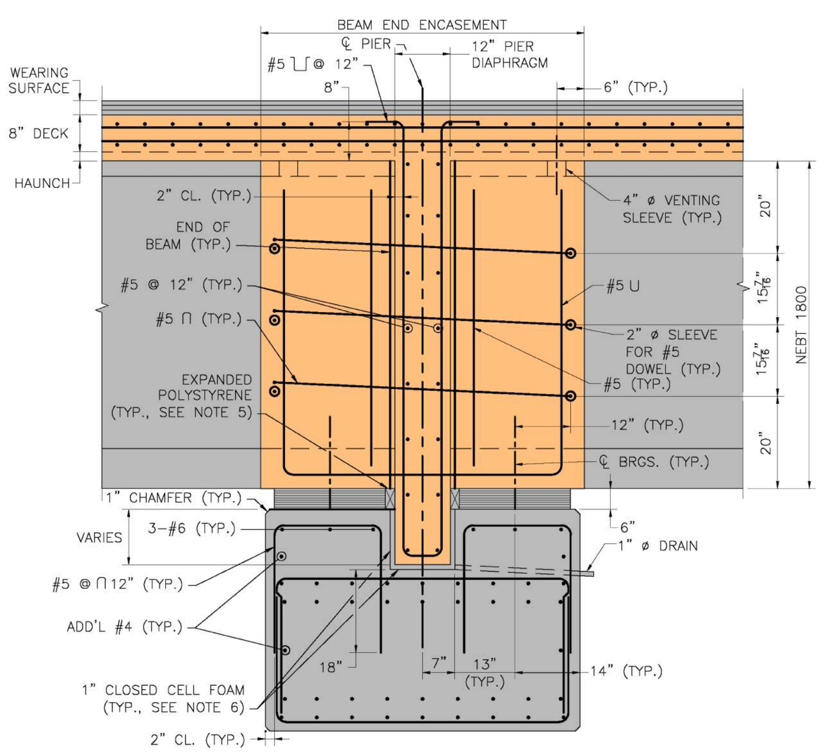
View beneath completed bridge showing the center pier and abutment.

they were the only MassDOT standard precast, prestressed concrete girder that had the load-carrying capacity for such a span and beam spacing. The NEBT 1800 girders also have a wide top flange, which facilitated the use of splayed-girder framing for the exterior girders, with girder spacings that varied from 6 ft 0 in. to 8 ft 10 in. The straight bulb-tee girders also accommodated the horizontally curved roadway deck slab that required variable width overhangs ranging from 2 ft 1 in. to 4 ft 0 in.

The girders were designed using the 2012 *AASHTO LRFD Bridge Design Specifications* methodology and were analyzed as simply supported for dead loads and continuous for live loads.The bridge was constructed in two stages, with the first stage being built immediately adjacent to the existing bridge. This construction method allowed the existing bridge to stay completely in service during stage I construction. The second stage of construction occurred within the approximate footprint of the existing bridge, while traffic was shifted to the new stage I structure.

Girder Design Features

The girders were made continuous for live loads through the use of reinforcing steel in the deck slab combined with a full-depth beam end encasement detail, which eliminated the need for an expansion or control joint over the pier.



Beam end encasement detail at pier, providing continuity for live loads and eliminating joints over piers.

This was a key element to this structure, given that one of the major deficiencies of the previous structure was leaky deck joints over the piers. The concrete girders also have a lower coefficient of thermal expansion, as compared with steel girders, which allowed for the use of simpler expansion joint details at the abutments. The simpler joint detail will require less long-term maintenance and offer better protection of the girder ends, where corrosion can typically be a problem.

Due to the long span length and bridge loading, the girder design used all 10 available harped strand locations within the girder. The girder design also required a concrete strength of 8 ksi, as opposed to MassDOT's standard 6.5-ksi concrete strength for prestressed concrete girders. MassDOT permits use of an increased concrete strength to avoid going to deeper sections or creating closely spaced girders. In addition to harped strands, the girder design required debonding for the first 18 to 24 in. for specific strands at the girder ends to reduce compressive stresses at the time of prestressing force transfer.

Providing durability

All elements of the structure, with exception to the approach slabs, are reinforced with epoxy-coated reinforcing bar, which is a MassDOT standard. MassDOT also requires the use of high-performance concrete in all bridge decks, end diaphragms, and precast, prestressed concrete beams.

MassDOT specifications require that high-performance concrete include the use of a corrosion inhibitor such as calcium nitrite and be air-entrained for freezing-and-thawing resistance. The use of these materials is specified in Massachusetts to provide structures that are resistant to the high-chloride environment to which they are exposed during long, cold winter months throughout their service life. These materials, combined with careful detailing, will provide a durable, economical structure with immediate and long-term cost savings.

Paul W. Berthiaume is a project manager and John F. Watters is vice president/director of structural engineering with GPI in Wilmington, Mass.