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Charles River Crossing: A Gateway To Boston

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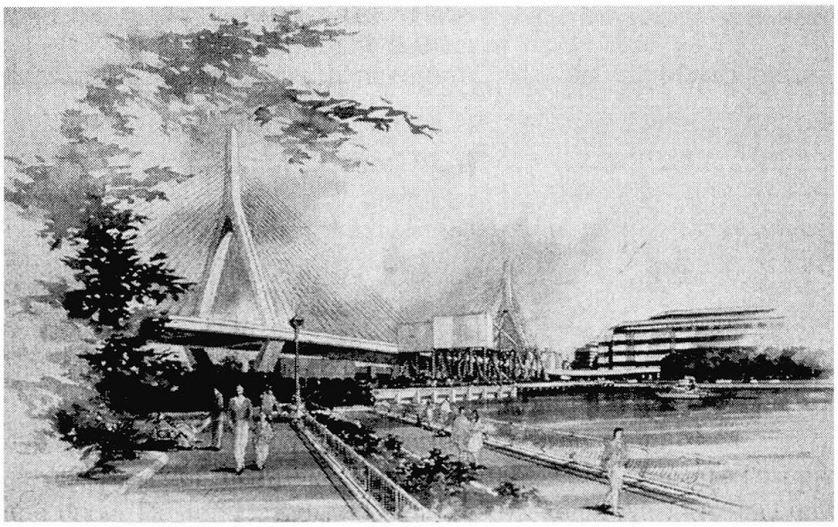
Abstract

Boston's Central Artery/Tunnel project is the largest infrastructure undertaking ever attempted at a single US location. It involves reconstructing Interstate 93 (I-93) by depressing it into a tunnel and subsequently removing the original elevated highway (known as the Central Artery). The second phase of the project will extend the Massachusetts Turnpike (I-90) through South Boston and under Boston Harbor to Logan International Airport. The new I-93 will emerge from the tunnel near the south bank of the Charles River and rise to cross the river on a cable-stayed bridge. This structure, unique in the world, will be both longitudinally and transversely asymmetrical. This paper discusses the planning, preliminary and final design and construction of this new gateway to Boston.



Artist's Rendering of Boston's Charles River Crossing

The Charles River cable-stayed bridge is an asymmetrical hybrid structure with cast-in-place concrete back spans and a composite steel main span with a precast concrete deck. The structure is on a 5% grade, emerging from the tunnel at the south end and tying into a three-level interchange at the north end. The five-span hybrid bridge (34-40-227-76-52 meters) will accommodate ten traffic lanes in the main span and eight lanes in the back spans. Cast-in-place concrete box girders form the back spans and two steel edge girders with floor beams and a precast deck with cast-in-place infills form the main span. In the main span, the deck system cantilevers out to support a two-lane ramp outside the cable plane on the east side of the bridge. However, in the back spans, due to interferences with an existing bridge, the ramp structure is supported separately.

The bridge's stay cable arrangement is also asymmetrical, with a single plane of cables anchored to the central median area in the back spans, and two inclined cable planes anchored to the edge girders in the main span. Transition from the concrete back span to the steel main span occurs at the transverse tension struts at the tower piers. The structure, as a consequence, is fixed at the tower piers. Tower foundations consist of large diameter drilled shafts. To prevent excessive pressure from being exerted on the nearby Orange Line subway tunnel, the shafts closest to the tunnel are installed within isolation casings.

This project has overcome challenges during all phases.

- **Planning:** Considerable effort, including participation by the community, architects, engineers and urban planners, was expended to arrive at the overall Charles River crossing area plan, which includes two bridges across the Charles River and interchanges at both ends. As a result, the type study process and selection of an appropriate configuration was a challenge.
- **Preliminary Design:** Once the structure type was selected, preliminary designs for steel, concrete, and hybrid alternatives were prepared. Each of these alternatives posed special challenges: anchoring at the south back span; tower configuration; cable anchoring in the towers; cable connection to the edge girders; transitioning from concrete to steel at the tower piers (for the hybrid alternative); thermal effects; shear lag effects; and torsion in the tower due to asymmetry, among others.
- **Final Design:** Design challenges continued after selection of the hybrid alternative as the best crossing option. Some modifications to the preliminary design were found to be beneficial, such as a spline beam cable anchoring system at the south end, control of torsion in the towers due to superstructure asymmetry, and cable anchoring improvements. At the south tower, soil liquefaction was also considered during a seismic evaluation.
- **Construction:** Innovations are being implemented such as ungrouted stay cables, coextruded PE pipe with a spiral bead to reduce vibration, and changes to back span construction methodology.

When complete, the Charles River Crossing will not only serve as a fitting gateway and recognizable Boston monument, but will also be the keystone of the massive Central Artery/Tunnel project. The structure, in harmony with the historic city, will also advance the state-of-the-art in US cable-stayed bridge technology.