BOSTON BRIDGE UPGRADE

Replacing the superstructure and renovating the substructure of an historic retractile bridge saved one of the last examples of this rare bridge type

The Summer Street Bridge was kept open to both pedestrian and vehicular traffic during renovation, all of which was staged from barges.

By Tom Quinlan, P.E., and Carl Goldknopf, P.E.

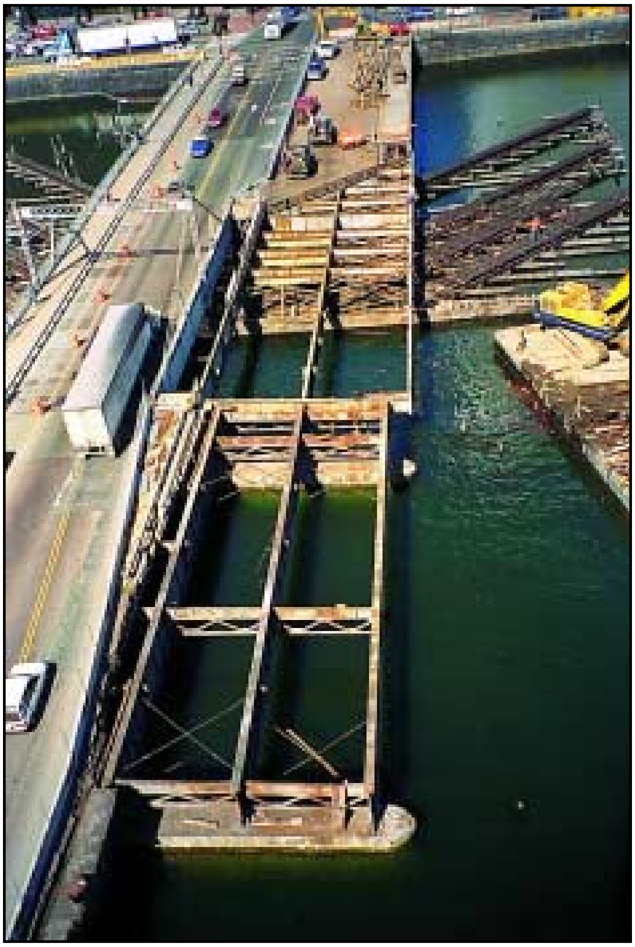
BOSTON IS A WONDERFUL AMALGAM OF THE OLD AND THE NEW, and the city is often faced with the dilemma of how to deal with historically significant structures. The latest problem revolved around a deteriorated 95-year-old movable bridge situated on a major vehicular and pedestrian route that connects the downtown business district with the South Boston commercial-industrial area. The bridge is the only known surviving example of an electrically operated, paired leaf, oblique retractile drawbridge—a bridge type developed and primarily used in the Boston area, beginning back in the mid 1850s. The Summer Street retractile bridge, built in 1899, represents the culmination in the evolution of this little known bridge type.

The condition of the existing bridge was critical. The steel superstructure was significantly corroded due to the harsh salt water environment of Fort Point Channel and the nearby Boston Harbor and the use of salt on the roadways during the winter. The substructure, constructed of stone masonry and concrete, was in general disrepair. Recent inspections and ratings required the bridge to be posted for an 8-ton H truck load limit.

The City of Boston Public Works Department, the Massachusetts Highway Department and the Massachusetts Historical Commission were all committed to preserving this important example of 19th century American bridge engineering. However, because of the condition of the bridge, its rehabilitation was critical. Important design issues included: maintaining its historic appearance; upgrading the bridge to carry HS20 truck live loads; keeping the bridge open to vehicular and pedestrian traffic during renovation; and retrofitting the bridge for seismic conditions.

After significant engineering analysis, it was determined that the existing substructure could be repaired, but the superstructure had to be replaced. By reusing several of the key historic bridge components, in combination with new structural steel, most of the original appearance and historic character would be maintained.

Several key historic bridge components will be refurbished and reused as part of the scheme to maintain the original appearance of the bridge. The original fascia girders of the approach spans will be utilized with rearticulated bearings. The seismic isolation bearings are to be hidden behind the shoe plates and bearing pins which originally transferred vertical loads to the roller nest bearings. Dummy roller nest bearings retain the appeal of the original construction. Other original bridge elements used in the rehabilitation included the Sampson Post Trusses, historic metal bridge railing, truck carriages and rails that supported and moved the drawspan. The refurbished truck carriages and rails will be supported on new timber draw pier framing and new timber piles. Facsimile roadway joints along the perimeter of the drawspan were fabricated and used with altered pavement colors to highlight the drawspan section of the bridge.



The original fascia girders of the approach spans are utilized with articulated bearings in the renovated bridge.

Historic Significance

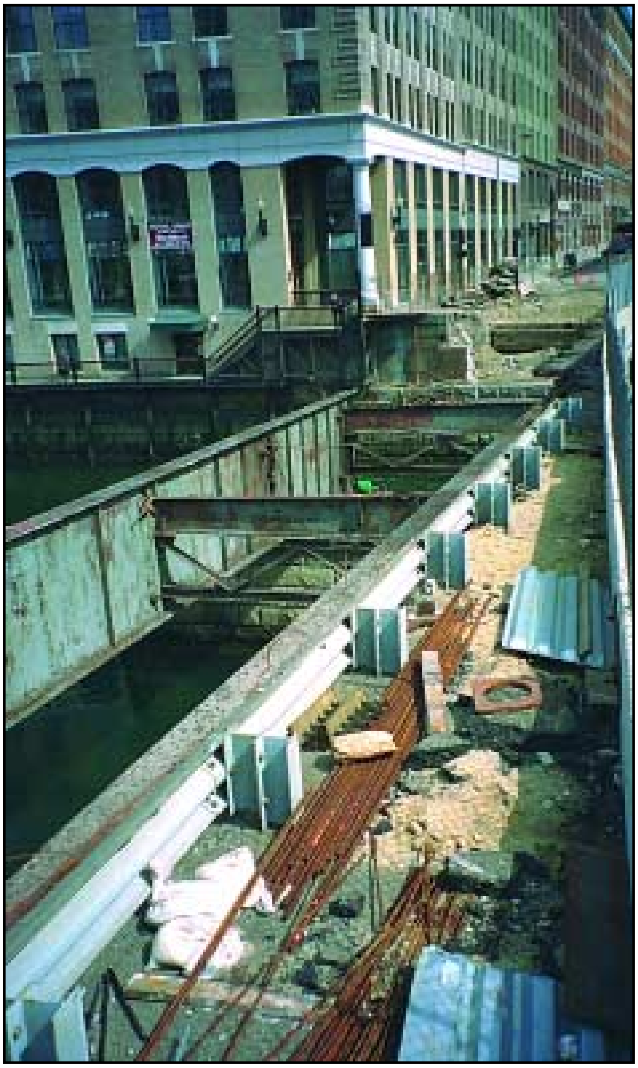
The original bridge was constructed over the Fort Point Channel, a tidal estuary that serves as anchorage for fishing, shellfishing and lobstering vessels, as well as pleasure boats and rowing shells. The surrounding area, known as the Fort Point Historic District, includes five of the eight known surviving movable bridges of the 19th century noted in the Massachusetts Highway Department historic bridge survey.

Built in 1899, the bridge is an example of early steel construction and includes riveted built up plate girders and rolled medium grade steel shapes. The overall bridge is 508 ft. in length. It is constructed on timber pile supported foundations. The structure consists of two fixed approach spans between 80 to 85 ft. in length, on each side of a movable horizontally retractable drawspan. The drawspan, when open allows for a 50-ft. wide navigation channel. Due to the severe deterioration of the drawspan and the lack of maintenance required to keep the bridge operable, the bridge was fixed by federal legislation in 1959.

One of the unique features of the drawspan are the use of Sampson Post Trusses, which support the cantilever end of the drawspan in the retracted position. A portal frame on each draw leaf consist of a pair of these Sampson posts which carry the ends of pinned eyebar stays attached to the drawspan girder in a trussed configuration. Four single and three double rolling truck carriages support each of the drawspan leafs on the draw piers adjacent to the bridge. The twin drawspan leafs were mechanically retracted at a 45 degree angle to the bridge centerline.

Proposed Rehabilitation

The rehabilitation of this bridge begins with the repair of the existing substructures, since it was determined that the foundations possessed the capacity to resist the new superstructure



One of the difficulties of the project was the site constraints, including the necessity of keeping the bridge open to traffic and working around nearby buildings.

design loads.

A new pile bent was designed to replace the foundation of the former drawspan. The new pile bent is constructed of 18 concrete-filled steel pipe piles, each 22-in. in diameter, driven to a 135-ton working load with a concrete pile cap. This foundation will support two new 89-ft.-6-in. long fixed spans, formerly occupied by the drawspan and a fixed triangular section adjacent to the drawspan.

Due to the inability of the existing granite masonry piers and abutments to tolerate large lateral forces and displacements, especially in the longitudinal direction, it was decided to incorporate lead rubber isolation bearings manufactured by Dynamic Isolation Systems Inc., to minimize the seismic forces delivered to the foundations. These bearings substantially reduce the inertial effects transmitted to the substructure, thus dramatically improving seismic performance during an earthquake.

A new six-span continuous steel superstructure constructed of M270 rolled wide flange shapes, with cover plates, replaces the existing longitudinal girders, transverse floor beams and roadway stringers. There will be 15 stringers, each 36-in. deep, spaced equally across the 100-ft.width of the bridge. The stringers were made continuous to limit the number of roadway joints to simplify maintenance, provide a more economical steel design, and distribute the horizontal forces evenly among the piers. A new neoprene compression seal was designed to provide the necessary expansion capacity at each end of the bridge.

The rehabilitated structure will require 920 tons of new structural steel and an additional 50 tons of new steel was used to temporarily strengthen the existing structure for traffic during the construction period. The new pile bent added another 50 tons of A252 steel to the project

The reconstruction, started in November 1994, is taking place in two phases in order to maintain vehicular and pedestrian traffic at all times, and is currently slated to be completed in early 1997. The project was jointly funded by the Federal Highway Administration, the Massachusetts Highway Department and the City of Boston. Structural engineer on the project is STV Inc., Boston; general contractor is The Middlesex Corporation, Chelmsford, MA; construction administrator is the Masschusetts Highway Department; project owner is the City of Boston; steel erector is Converse Construction, Milton, MA; and structural steel fabricators are AISC-members Precise Fabricating Co. and High Steel Structures.

Tom Quinlan, P.E., is a project engineer and Carl Goldknopf, P.E., is chief engineer with STV Incorporated in Boston.