1996 Prize Bridge Award: Short Span
South Station Connector Ramp

DRIVER'S IN DOWNTOWN BOSTON ARE FOREVER BEMOANING the city's spaghetti-like streets, so a good roadway was crucial to the success of Boston's South Station Transportation Center (SSTC). The SSTC combines intercity and commuter railroad operations, intercity, regional and local bus operations, rapid transit, an airport link and automobile traffic onto a single location close to major Interstate highways and within walking distance of Boston's retail and financial districts. Phase II of the project involves construction of a new consolidated bus terminal and parking on air-rights above the track and platforms. It includes the construction of two structural decks, a railroad ventilation system, bus terminal facilities and roadway ramps from local streets for access to the bus terminal and parking.

The project is being constructed in coordination with Boston's Central Artery/Tunnel Project, which includes the South Bay Interchange between the Central Artery and I-90 in the South Bay area immediately adjacent to the SSTC. In addition to the mainline roadways and ramp connections between these highways, ramps connecting city streets with the SSTC will provide a system of preferential high occupancy vehicle lanes designed to improve the flow and traffic capacity through Boston and to Logan Airport. The new ramp system is a horizontally curved trapezoidal steel box girder. Innovative designs for the complex framing of the ramp structure were required to meet severe site constraints, which included coordination to accommodate and facilitate future Central Artery construction, as well as anticipate the eventual integration of the ramp structure into the permanent ramping system for the South Bay Interchange.

The ramp structure is designed to span three future below-grade tunnel approach ramps and 11 South Station railroad tracks with a small, compact distance of only 800'. The horizontal layout restrictions, vertical clearance requirements and the required connection to a bus terminal building structure dictated a very complex ramp structure. The developed structure geometry required the merging of two separate ramps into one structure and later the separating into three ramps with a small 340' distance.

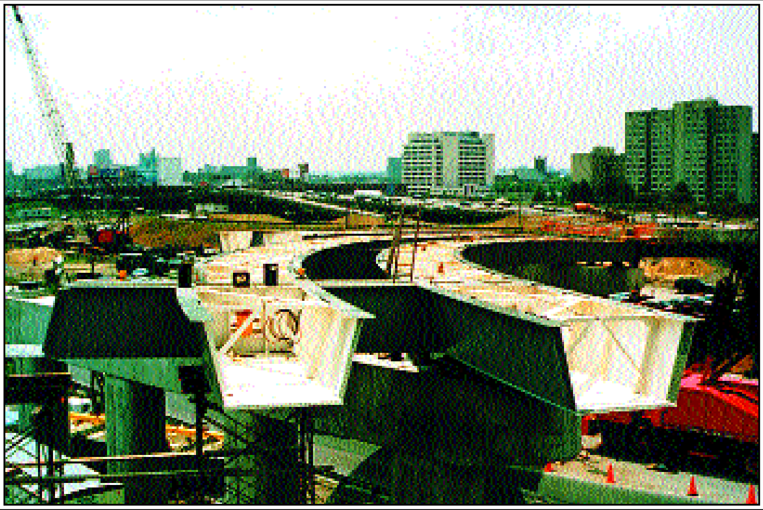
The new steel box girder ramp has 16 spans supported by architecturally enhanced concrete piers. The span lengths range from 30' to 105'. The smaller span was required at the terminal building locations in order to minimize reactions at the building/ramp interface. Many of the horizontally curved box girders have a radius between 120' and 200'. All of the steel box girders have a constant web depth of 54". At one location within the first steel unit, a steel framed-in capbeam was required to meet geometric constraints.

The steel portion of the box girder superstructure includes: the single cell steel trapezoidal box girders; two double celled varying width steel box girders; a steel box framed-in capbeam; permanent interior and exterior steel diaphragms; and a permanent full-length steel top lateral system. The majority of the steel members were designed using 50 ksi material. The steel trapezoidal box girders have constant depth webs with an inclination of the web plates to a plane normal to the bottom flange of 1:4. Only two box girder web plate sizes were used for the entire ramp. The sizes were selected such that the majority of the box girder webs would not require transverse or longitudinal web stiffeners for design bending, shear and torsional forces.

Unusual Structure

A steel box framed-in capbeam is included in the first steel box unit. In general, this framed-in capbeam consists of two vertical webs with separate top and bottom flange connection plates connected by fillet welds on each side of each web and then tied together with a bolted full-width flange plate for each set of flanges to create a box shape. The framed-in capbeam depth matches the depth of the longitudinal box girders primarily for aesthetic purposes. The webs and connection flanges that are welded together are discontinuous between webs of the box girders. The top and bottom full-width flange plates are continuous from outside box girder to outside box girder across the width of the bridge. The design of the framed-in capbeam included shear lag effects for the wide flange plates. The framed-in capbeam webs are attached to the longitudinal box girder webs by a bolted end plate connection welded to the capbeam webs. The shallow depth box framed-in capbeam, which is designed as unstiffened on its exposed surfaces, provides a smooth member, which compliments the longitudinal box girders.

The first steel box girder unit contains several box girders that are merging or framing into a primary supporting box girder. Box girder G104 is a curved single cell trapezoidal box girder for the majority of its length. A portion of the girder in the last span of its unit is a varying width box girder with an additional central full-depth vertical web. Top and bottom connection flanges are fillet welded to the central web.



Judges Comments:

"Incredibly complex in design and construction but successfully executed with curved girders and trapezoidal boxes"

Project Data

Steel wt./sq. ft. of deck:
40 lbs.

Cost:
$15 million

Steel Tonnage:
1,050

Please note that red text denotes an AISC member

Project Team

Designer:
Howard Needles Tammen & Bergendoff Corporation
Boston

General Contractor:
J.M. Cashman, Inc.
East Boston

Fabricator:
Harris Structural Steel Co., Inc.
Piscataway, NJ *

Erector:
Saugus Construction Corp.
Andover, MA

Owner:
Massachusetts Bay Transportation Authority

These flanges are then bolted to the main box girder top and bottom flange plates. Two separate trapezoidal shaped box girders frame directly into the midspan of box girder G104. The web connections at the ends of these two box girders are very similar to those provided for the framed-in capbeam web connections to the longitudinal boxes.

The top and bottom flange connections to box girder G104 are made using conventional truss type bolted gusset plates. All of these connections provide an AASHTO fatigue category "B" detail to the primary supporting box girder members. Because the required geometry for these connections produced some unfavorable attachment angles, some additional solid plate full-depth supporting diaphragms capable of providing full moment and shear capacity were used in the immediate vicinity of these box girder connections to provide added redundancy to the superstructure framing system.