1996 Bridge Merit Award: Grade Separation 20th Street HOV Structure/Denver Union Terminal Ramp

ProjectData

Steel wt./sq. ft. of deck: **70 lbs**

Cost: **$2 million**

Steel Tonnage: **380**

Flanking the left field wall of Coors Field, home to the Colorado Rockies baseball team, is the new 20th Street HOV Viaduct, a three-tiered roadway system with mainline 20th Street tunneled below the Denver Union Terminal railroad tracks and city streets and the high occupancy vehicle structure above. The Denver Union Terminal (DUT)Ramp separates buses from the remainder of the HOV traffic and is part of a system that operates as a computer-controlled reversible highway, carrying in-bound traffic in the morning and out-bound traffic in the evening.

The DUT Ramp is the only steel segment in an otherwise concrete box girder structure. For aesthetic continuity, the steel was painted to match the remainder of the bridge.

Completed in the fall of 1994, this 6.6-mile, $16-million project was undertaken to replace an aging thoroughfare into downtown Denver. As could be expected, the congested urban setting complicated the project. Also complicating the project was the requirements by the railroad companies that share tracks in the DUT that there be no interruption in train movements and no supporting falsework in the track area—a requirement that all-but-mandated the use of steel.

Project Innovations

The DUT Ramp bridge crosses the rail yard and is threaded between Denver's Union Station main terminal building and loading platform. A system of three welded steel plate girders create the 411' radius. The two spans of 192' and 171' rest on a single-column pier. Because of the need to maintain vertical clearance over the railroad tracks, no portion of the pier cap could protrude beneath the soffit of the superstructure. With the center column as

Judges Comments:

"Graceful curves with good attention to detail"

"Good transition from steel to concrete"

the only direct support, the exterior girders frame into an integral pier cap, which is cantilevered off the column. The cap was formed with steel plates and later filled with concrete and post-tensioned. By eliminating the typical massive concrete cap below the girders, this detail results in a graceful appearance for the steel span.

To augment the designer's understanding of the structural behavior of the bridge, a three-dimensional finite element analysis was performed, which allowed the engineer to hone the bridge design and proportion the section for efficient material usage.

Architectural Considerations

Typically, a superstructure with such severe curvature would be framed with steel box girders due to their superior torsional resistance. However, the design architects wanted to make the steel portion visually distinct so steel I-girders were used instead of box girders. This resulted in significant torsional effects in the girders and required extensive use of cross-frames to distribute the forces. These diaphragms were themselves subject to significant stresses, which required them to be designed as main members for fatigue considerations.

The DUT Ramp frames into the main concrete structure at a Y-intersection where it is supported on a corbel. In order to balance dead loads and reduce torsional effects in the gore point of the concrete structure, the concrete/steel interface occurs approximately 30' beyond the supporting pier. However, a deep cope was required in the steel girders in order to allow sufficient depth in the concrete structure to provide an adequate supporting corbel.

Project Team

Designer:
LONCO, Inc., Denver

Consultant:
MK Centennial, Arvada, CO

General Contractor:
Flatiron Structures Company, Llc. Longmont, CO

Fabricator:
Trinity Industries, Inc., Houston

Erector:
Grett Steel and Iron Company, Inc., Denver

Owner:
Regional Transportation District—Denver