1996 Prize Bridge Award:
Grade Separation
Route 19 - Interstate 80 Interchange

Judges Comments:

"A very complex ramp design with an innovative use of steel to solve the tight radius"

"Great architectural treatment of the abutments"

After 20 years of problems created by a substandard design that was only intended as a temporary band-aid, severe congestion headaches were remedied with the construction of the new Route 19 Freeway Interchange with Interstate 80 in Paterson, NJ. The new interchange not only reduces congestion and creates a rational traffic circulation plan, but also provides a direct link from I-80 to the city's central business district.

The project had been on the drawing boards for decades, but resistance to the original alignment plan, which called for a peripheral highway around the city and through a historic district, put a halt to the project in 1971. Instead of a modern interchange, a temporary connection was installed. Left unbuilt was the needed interchange between the region's two major roadways. Finally, in 1973, the New Jersey Department of Transportation began new studies, which indicated that any highway realignment would have significant adverse effects. As a result, the original concept of a peripheral highway was abandoned and plans were developed for the new interchange, which opened to traffic in October 1992—seven months ahead of schedule.

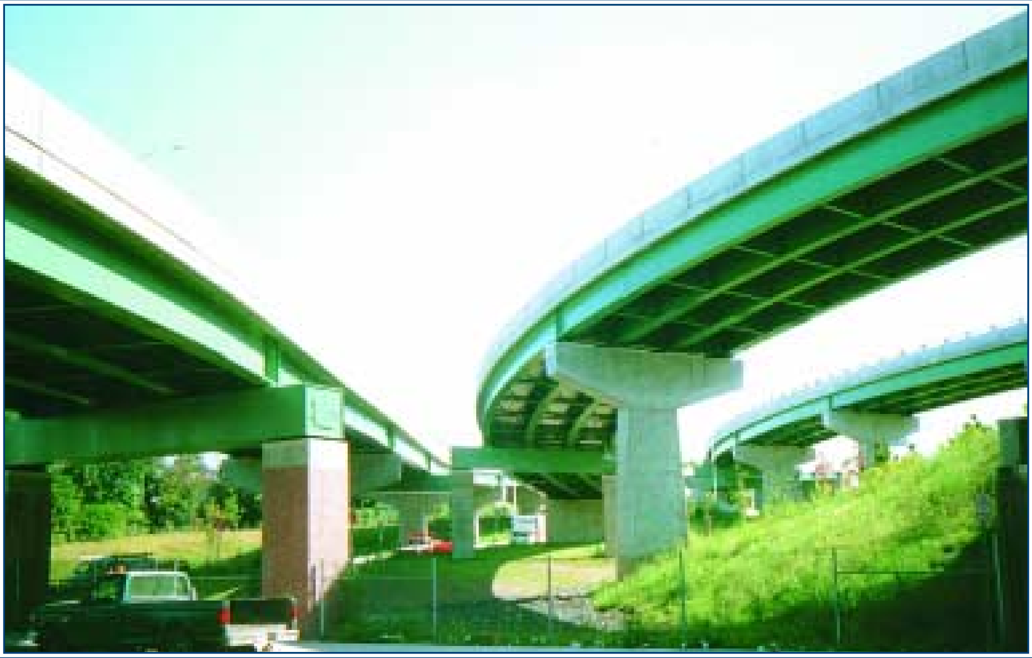
Since the interchange was bordered by Route 80 to the south, the Great Falls Historic District to the west and north, and residential neighborhoods to the east and north, the ramp configuration was determined in large part by the availability of vacant land.

Ramp A comes off Route 80 westbound and provides the direct link to Main Street and downtown Paterson via a new boulevard. The minimum girder radius is 249' and the structure is 793' long.

Ramp B, which is 1,115' long, also carries traffic from Route 80 westbound, but delivers it onto Route 19 southbound. Minimum girder radius is 176'.

Ramp C carries traffic from Route 19 northbound to Route 80 westbound and is 730' long with a minimum girder radius of 203'.

Typical roadway width is 24' from gutter line to gutter line plus two 1'-9" parapets, but widens to 28' on the portion of Ramp B where the radius is at its minimum. Ramp superstructure consists of concentric, horizontally curved steel plate girders with composite concrete deck. Girder spacing is typically 8', but reduces to 7' on the widened portion of Ramp B.



Substructure is reinforced concrete hammerhead piers, except in several instances where steel box girder cap beams on reinforced concrete columns are used to straddle on-grade roads. With few exceptions, piers and abutments are radial. Maximum profile grade is 7.6%, which occurs on Ramp B. Maximum cross slope is 6%.

Design Challenges

Accurate design and detailing of the highly complex ramp geometry was the critical consideration in developing the Contract Plans. More than 3,000 geometric points on the steel ramp structures were computed and located in three dimensions. Computer generated plots were used to check all critical dimensions and individual girders, cross frames, masonry plates and bearings were thoroughly detailed in the contract plans to account for all variations resulting from the vertical and horizontal geometry parameters. Cambers for dead load, live load and vertical curve correction were computed at tenth points along each girder. Final deck elevations were given at quarter points along the gutter lines and PGL for each span. Extensive geometric detailing and review of shop drawings resulted in ramp superstructure steel that was fabricated and erected without significant geometric error.

Because of the site constraints imposed by the adjacent historic district and residential neighborhood, the ramps are by necessity very tightly curved structures with a minimum radius of 176'. Due to profile constraints, the only practical superstructure for this project was curved steel I-girders. However, curved girders present some inherent problems that

Project Team

Designer:
Hardesty & Hanover, Llp.
New York City

General Contractor:
E.E. Cruz Co., Inc.
Holmdel, NJ

Fabricator:
Carolina Steel
Rolled Die Co.
Greensboro, NC *

Erector:
Cornell & Company, Inc.
Woodbury, NJ

Owner:
New Jersey Department of Transportation

Please note that red text denotes an AISC member

Project Data

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

Cost:
$26.7 million

Steel Tonnage:
1,867

needed to be overcome during design and detailing.

Unlike straight girders, which are designed only for normal and shear stresses due to bending and shear, curved girders also are designed for normal stresses due to non-uniform torsion. In a tightly curved structure, the results are very wide flanges and closely spaced full-depth cross frames, often with lateral bracing. On this project it was decided to eliminate lateral bracing to simplify fabrication and erection. Careful attention was paid to details to minimize out-of-plane distortions and resulting high fatigue stresses.

Bearings for curved girders must allow for rotation about any horizontal axis and, in the case of expansion bearings, both longitudinal and transverse movement. On the Route 19 ramps, spherical bearings were used at all curved spans and radial bearings were used at all straight spans.

Because a single curved girder is unstable, the contract specifications required the curved girders to be erected in pairs, complete with cross frames. It also specified that the steel for the curved girder spans, including cross frames and bearings, had to be completely pre-assembled in the shop and then match marked for re-assembly at the site.

Box Girder Welding Procedure

THE GEOMETRY OF THE RAMPS NECESSITATED THE USE OF STEEL BOX GIRDERS—the only fracture critical members in the project—as pier caps at six piers. Welding details and procedures were developed to simplify fabrication while still meeting AASHTO fracture critical weld requirements. The box girders were detailed so that the tension flange to web groove welds were made first, forming a U-section. This allowed the tension flange welds to be back-gouged. The compression flange to web welds, which close the box section, were then made using back-up bars. Thus all welds were made from outside the box.

At two piers, the boxes have cantilevered sections. A bolted splice was located at the contraflexure point so that the same welding procedure was used throughout the box.