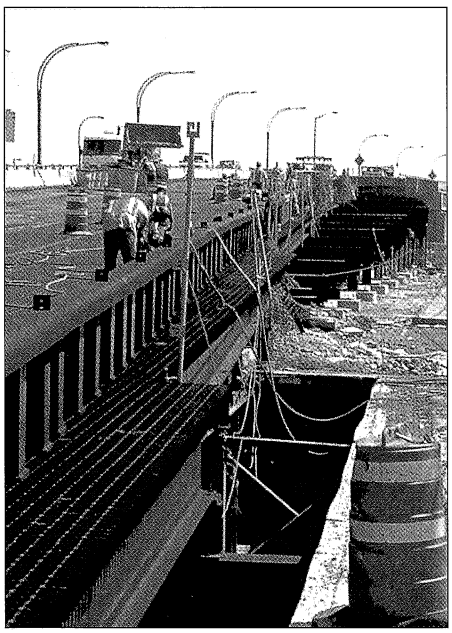
Cross Bronx/Bruckner Expressway Interchange

The Cross Bronx (I-95)/ Bruckner (I-278) Expressway Interchange is one of the most heavily traveled stretches of highway in the New York area, carrying 250,000 vehicles a day. By the early 1990s, the 139 spans of the elevated structures, built between 1968 and 1970, had begun to show the effects of the high volume of traffic, and in particular the truck traffic that used the interchange. The existing concrete deck was badly damaged and severe corrosion was evident in the exposed reinforcing steel throughout the structures. In 1992, the New York State Department of Transportation (NYSDOT) carried out a thorough inspection to identify the extent of deterioration of the deck and also performed Level 1 load ratings to determine the load-carrying capacity of the steel superstructures.

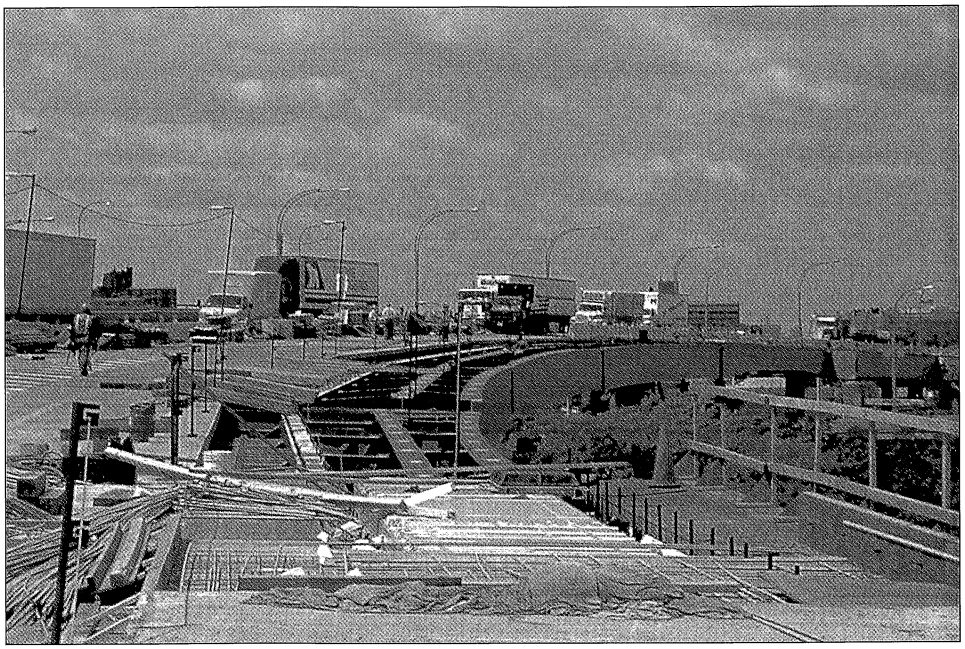
Photos in this article: Courtesy of Hardesty & Hanover, LLP

In 1993, the bridge engineering firm Hardesty & Hanover was called in to develop design plans for the rehabilitation of the interchange. At the time, the overall scope of the project consisted of repairing the deteriorated steel superstructures and concrete substructures and installing a new high-density concrete overlay to repair the existing deck.

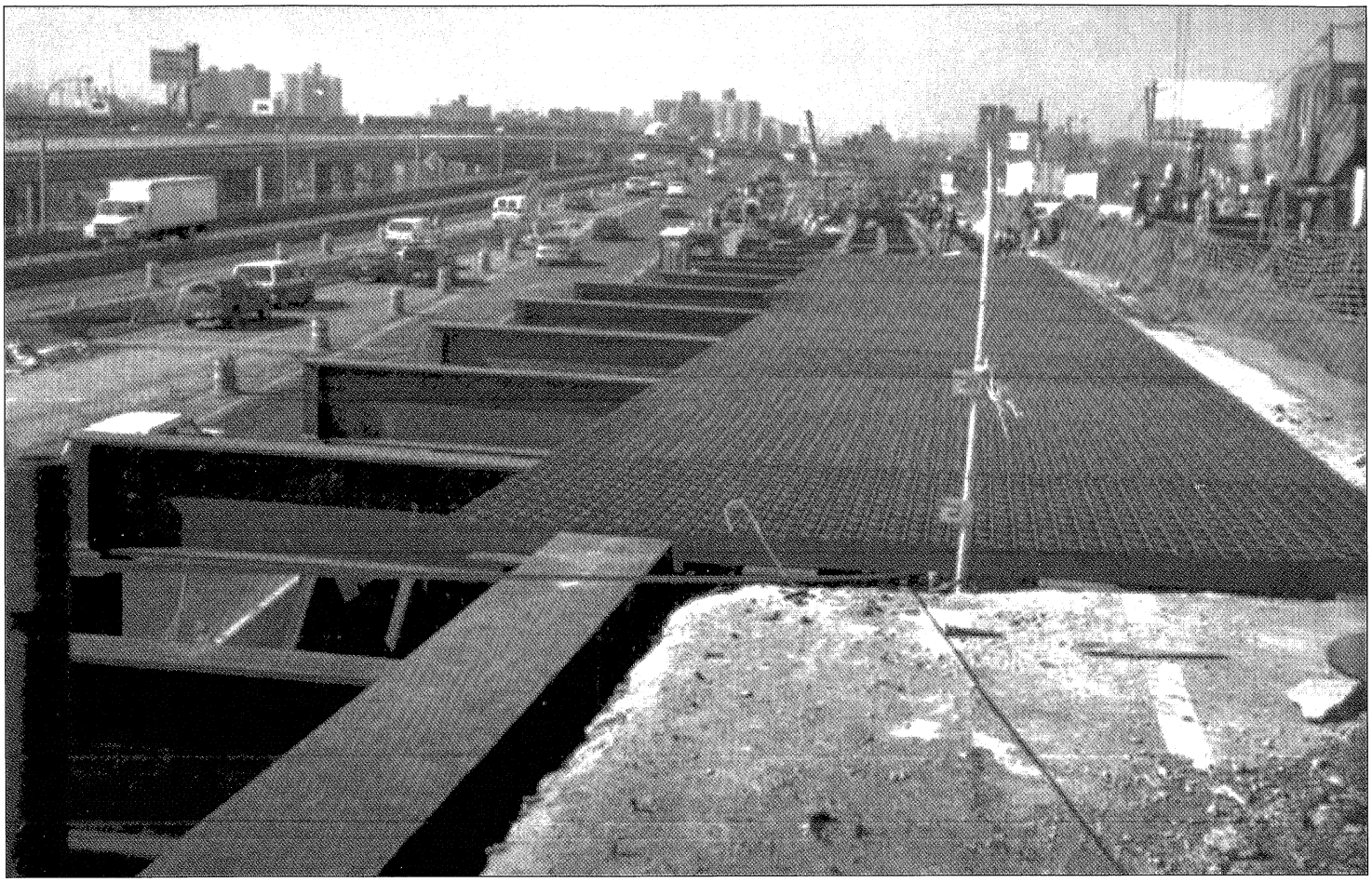
The firm's subsequent investigations revealed that approximately 30 percent of the total deck areas would require deep removal of deteriorating concrete. In addition, approximately 10 percent of the deck area would have to be entirely replaced. Progressive deterioration suggested that by the date projected for letting the contracts, as much as 10 percent more of the deck would have to be repaired as well.



Other structural deficiencies included fatigue cracks in welds between the steel girder bottom flange and bracing connection plates, badly deteriorated reinforced concrete deck, improperly functioning expansion joint elements, and deficient steel rocker bearings unable to resist seismic loads. Further studies also indicated that the existing roadway super-elevation did not meet the current design standards of the American Association of State Highway & Transportation Officials and the NYSDOT, resulting in higher-than-average accident rates.



The scope of the project was ultimately modified to incorporate structural and safety improvements into the rehabilitation project. The new scope included replacing 1.1 million sq. ft. of the 7 1/2-in. reinforced concrete deck with new 8 1/2-in. monolithic deck; fabricating and installing 10,000 linear ft. of steel armored joint for the replacement deck; fabricating and installing 1,100 steel bolsters for the replacement of the steel rocker bearings with new elastomeric and multi-rotational bearings; and removing and replacing 2,200 sets of fatigue-prone connection details. The eastbound Cross Bronx Expressway would also be widened by adding new longitudinal girders and modifying the existing steel box girder cap beams in the steel superstructure.



Four spans of the steel superstructure were targeted for reconstruction and the existing concrete substructure modified to accommodate profile adjustment along the westbound Cross Bronx Expressway. In addition, a section of on-grade pavement would be reconstructed to add a new merge lane along one segment of the expressway. The replacements to the superstructure and the widening of the roadway required a total of 2,280 tons of ASTM A709M Grade 345 (A709 Grade 50) steel.

Complex Alignments

The multi-level structures and the number of ramps and roadways that feed into the interchange make it one of the most complex in New York State, said Daniel Wan, principal associate at Hardesty & Hanover. The length of the interchange from east to west is slightly less than a mile, and the length of the elevated structures totals just over three miles. Seven elevated ramps connect to four major arteries and local streets. Underneath the interchange, the Hutchinson River Parkway runs from north to south, carrying six lanes of non-commercial traffic.

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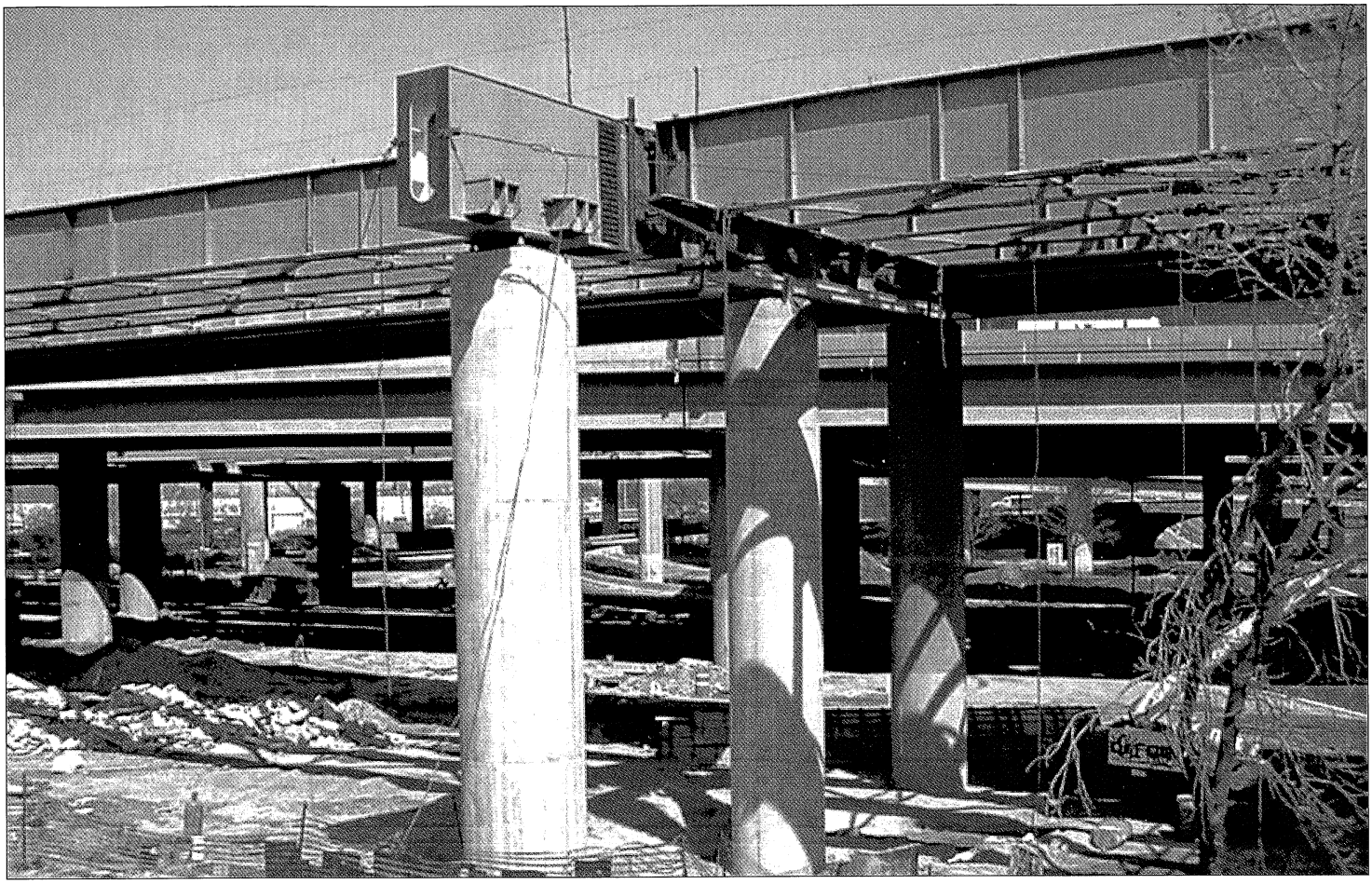
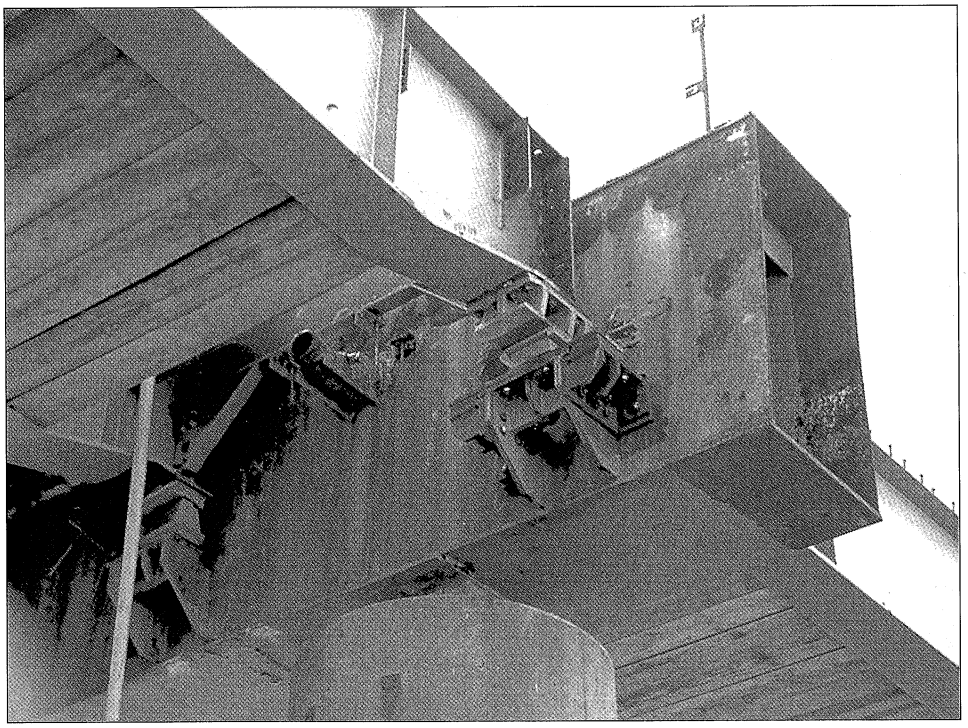
"One of the major challenges in the job, was to perform the rehabilitation project without undue interference with traffic or maintenance," Wan explained. "This was accomplished by carefully sequencing the work in four stages and by erecting three temporary structures to maintain traffic flow during reconstruction."





In addition to two ramps, these included the construction of an 820-ft. lightweight crossover bridge to carry two lanes of traffic from the westbound Cross Bronx Expressway to the southbound Bruckner Expressway. This structure consisted of an open grid steel deck, steel traffic barriers, and a steel stringer and floor-beam system to minimize the deadweight to be supported by the existing steel superstructure.

The temporary structures made it possible to avoid detouring traffic onto local streets and obviated the need to construct additional towers to support the unbalanced steel superstructure during the interchange reconstruction. Nonetheless, it was still necessary for the contractor to erect 53 temporary steel supports at various points throughout the interchange to support the existing superstructure during the different phases of construction.

Widening the eastbound Cross Bronx Expressway required the installation of new pile foundations and the extension of 14 existing steel box girder cap beams to support the new longitudinal girders. Modifications to the substructure included constructing new exterior columns on new pile foundations, demolishing one of the two concrete columns at each pier and replacing it in a new location.

The addition and reconfiguration of the columns provided better load distribution and improved the stability of the extended cap beams, according to Wan. "At one location, however, the extension of the cap beam would have impeded the vertical clearance of a service road beneath the expressway, so a reinforced concrete inverted cap beam was designed to replace the existing steel beam. The bottom flange of the specially designed beam provides bearing seats to support the existing longitudinal girders."

Improved Safety

Adjusting the profile of the westbound Cross Bronx Expressway to correct the design deficiencies and improve safety was achieved by partially replacing four spans of two three-span continuous steel superstructures. This was performed in three stages and entailed replacing the steel box girder cap beams with new reinforced concrete cap beams constructed in segments. Four spans of the longitudinal girders were removed in phases, and new girders were erected in accordance with the geometry of the new roadway profile.

Temporary towers were erected to support the remaining segments of the steel cap beams until they were replaced. This option was selected over a lengthier and more complicated alternative that would have required lifting the longitudinal girders and severing the existing cap beams to perform the adjustments to the super-elevation. The chosen option allowed the end span of each three-span continuous superstructure to remain in place, and eliminated the necessity to field-splice the cap beams. The existing steel fascia girders remained continuous over the new cap beams, spliced to the new fascia girders approximately 49 feet from the intermediate piers.

Given the critical nature of the interchange as a major connection point, the $152 million rehabilitation project was performed on an accelerated schedule. Compressing what would normally have been a 24-month design phase, the engineers prepared the design plans and contract documents for the complex job in only 15 months. This, combined with an innovative contractor's incentive program, enabled construction to begin in July of 1999 and be substantially completed by December 2001. The interchange was completely reopened to traffic in late December, 17 months ahead of the original 48-month schedule.

CROSS BRONX/BRUCKNER

Owner:
New York State Department of Transportation, New York, NY

Structural Engineer:
Hardesty & Hanover, LLP, New York, NY

General Contractor: DeFoe Corp., Mount Vernon, NY

Steel Erector: DeFoe/Rice Joint Venture, Mount Vernon, NY