The view inside one of the eastbound bridge's box girders.

Paerdegat Basin Bridge

The City of New York uses High Performance Steel, for the first time in history, in the first phase of a massive overhaul of the Belt Parkway.

WHEN NEW YORK'S BELT Parkway opened in 1941, its daily traffic flow averaged 20,000 vehicles per day. Since then, with the opening of JFK International Airport, the growth of suburban communities on Long Island, and construction of the Verrazano-Narrows Bridge, demand has dramatically increased on the parkway, which now sees nearly 150,000 vehicles each day. Time and traffic have taken their toll on the seven bridges serving the parkway, many of which received poor ratings in biennial inspections by the New York State Department of Transportation (NYSDOT) in the past years. In 2009, after determining that replacement of the aging structures was the most cost-effective solution to alleviating their flaws, the New York City Department of Transportation (NYCDOT) began their extensive reconstruction. The five-year project involves instituting wider lanes, safety shoulders, median barriers, as well as super-elevation of the roadway around curves and realignment of the approaches to each bridge to improve sightlines. This work, along with improvements to drainage on the bridges, is designed to reduce accidents. Additional projects along the Belt Parkway will enhance bicycle and pedestrian access and restore some historical character to the Robert Moses-era route with new landscaping, railings, lighting, and stone elements. (The entire Parkway project won a Design Excellence award in 2006 from the NYC Art Commission.)

The first phase of the undertaking includes the Belt Parkway bridge spanning Paerdegat Basin, the redesign of which was assigned to NYCDOT's In-House Design (IHD) team. Due to damage to one of its twelve cast-in-place concrete bents and to long-term structural deterioration of its primary members and concrete deck, the Paerdegat bridge has been under continuous monitoring and a 5-ton weight restriction since September 2004. Still, nearly 150,000 vehicles use the 70-year-old structure daily, many on their way to JFK, so the project team was required to keep three lanes of traffic flowing

during peak hours and allow pedestrian access at all times.

In order to accomplish this, the IHD team first considered building a six-lane bridge to one side of the existing structure. However, limited right-of-way on either side of the old bridge restricted them to a split design that alternated travel direction so that three lanes remained open for east- and westbound traffic during the customary periods of heavy volume.

Maintaining traffic flow was but one of the project's principal concerns. Durability of the structure was another, and the solution to this represented one of the project's most exciting aspects. For the first time in the city's history, High Performance Steel (HPS) with a yield strength of 70 ksi was being used to build bridges. Although HPS has been used in hundreds of bridges elsewhere in the United States, NYCDOT needed to explore how it could take advantage of HPS girders without sacrificing strength, durability or tried-and-true economical designs. Developed nearly two decades ago, HPS has become increasingly popular for bridge projects due to the cost and weight savings it can provide. The material also resists atmospheric corrosion, eliminating the need to coat steel bridges in most environments.

Construction of the Paerdegat bridge project began in April 2011 with erection of a new eastbound bridge, south of the existing bridge. (The westbound bridge to the north is scheduled for erection in the summer of 2012.) The eastbound bridge was designed as a five-span structure with spans of 60, 80, and 90, 80 and 60 meters in length. Due to the new bridge's curved shape and increased span lengths, both east- and westbound designs incorporate three HPS 70W steel trapezoidal box girders to resist torsion. Weighing more than 900 metric tons each, box beams for the eastbound bridge are 2.4 meters deep, 3.6 meters wide at the top, and 370 meters long. Box beams for the three-span westbound bridge, at 2.5 meters deep, 3.6 meters wide at the top and 250 meters in length will weigh approximately 600 metric tons, reflecting the 120-meter difference in length.

In order to eliminate what the DOT called "substandard" sight distances on the original bridges and accommodate the new,

Above For the first time in New York City's history, the NYCDOT opted for High Performance Steel (HPS) to construct the bridge's box girders.

Opening spread: NYCDOT Division of Bridges; this page: Northeast Structural Steel

Top: Northeast Structural Steel; right: NYCDOT Division of Bridges

Right Box beams constructed with Grade 70 HPS for the five-span eastbound bridge are lifted into place. **Below** A worker from steel erector Northeast Structural Steel.

longer spans, the team had to raise the roadway elevation by nearly 2.2 meters. Because a large amount of fill was added behind the bridge's new abutments to achieve this, the approaches to the bridge were preloaded with surcharge and equipped with weep drains to resolve the settlement of organic soil layers. Seismic isolation bearings distribute forces on the bridge's substructure. Eliminating joints at the piers created a smoother driving surface, but also decreased the likelihood of leaks and deterioration in the future.

In addition to a design that will withstand the test of endurance faced by all NYC bridges and improve conditions for drivers, the southern structure also makes the crossing easier for pedestrians and bicyclists. They will have a dedicated path separated from traffic by a concrete barrier on the bridge and by a 15-foot-wide grass mall on the roadway. With less than half the number of piers, the size of the navigation channel beneath the bridge has also been increased, a boon to those who prefer to travel by boat.

As with any project, not to mention one that will serve most of the city's population at one time or another and must be erected over water, the bridge required a high level of coordination between trades. "The contractor and fabricator were instrumental in developing all procedures from fabrication through erection and final splicing," says Anil Vyas, deputy chief engineer of the Bureau of Engineering Review and Support for NYCDOT's Division of Bridges. Members of the NYCDOT Fabrication Engineering Unit stayed in close contact with the steel subcontractors via weekly technical teleconferences that kept work flowing smoothly and on schedule.

Though the structural steel fabricator had experience in fabricating tub girders of Grade 70 HPS, this was their first time fabricating a non-hybrid girder

Above The completed eastbound crossing has less than half the number of piers as the older bridge, increasing the size of the navigation channel beneath.

consisting of Grade 70 HPS webs and flanges. (A hybrid steel girder is a welded girder with different steel grades in flanges and web. Though the bridge's internal stiffeners and connection plates are Grade 50 steel, its girder structure is not considered a hybrid.) Because of the variety of steel grades used, with their varying thicknesses and associated welding processes, the fabricator performed a series of preliminary tests to ensure the strength of each weld, identifying the procedure for each weld detail on specialized shop drawings. New York State's Steel Construction Manual (NYS SCM) does not address HPS 70W, so welding and fabrication were performed in accordance with the AWS D1.5 and the AASHTO Guide Specification for Highway Bridge Fabrication with HPS 70W Steel.

The welding process presented other challenges requiring special procedures. Not only is it more difficult to predict High Performance Steel's reaction to heat from welding, it is also more difficult to blast clean because mill scale adheres more tightly to the surface. For this reason, Grade 70 HPS web plates were blasted separately, before stiffeners were welded on, in order to ensure a uniformly clean finish.

Contributions from the project's subcontractors didn't stop at the fabrication shop; once girders were trucked to the site, structural steel erector Northeast Structural Steel proposed installation of temporary work trestles adjacent to the new bridge location in order to erect the steel over the water. The materials used for erection of the eastbound bridge will be recycled and relocated to the north side of the project for erection of the westbound roadway. Almost all of the erection was performed with a single Liebherr LR1400, 440 Ton Crawler Crane, but certain maneuvers, including erection of the centermost girders, required two cranes to work in tandem. Northeast also erected temporary falsework supports to prop up individual tub girder segments between piers; once splices were complete, these were removed.

Because the Paerdegat Basin bridges are located in the tidal wetlands of the Gateway National Recreation Area, mitigation of environmental impacts has been and continues to be a priority for the project. But once work is complete the new structures with their corrosion inhibiting coating will require little maintenance, instead offering commuters—an estimated 200,000 per day by 2029—an improved Jamaica Bay crossing and a glimpse of the many modernizations coming to the Belt Parkway in the years ahead.

Above The existing Paerdegat bridge (top) and renderings of the new eastand westbound crossings, scheduled for completion in the summer of 2012.

This spread: NYCDOT Division of Bridges

PAERDEGAT BASIN BRIDGE

Location: **Belt Parkway, Brooklyn, NY**
Owner: **NYCDOT Division of Bridges**, *New York, NY*
Architects: **NYCDOT Division of Bridges In-House Design**, *New York, NY*
Structural Engineer: **NYCDOT Division of Bridges In-House Design**, *New York, NY*
Geotechnical Engineer: **Earthtech**, *New York, NY*
Environmental Engineer: **AKRF**, *New York, NY*
Construction Management: **NYCDOT Bureau of Bridge Capital Design and Construction**, *New York, NY*
General Contractor: **Tully/Posillico Joint Venture**, *Flushing, NY*
Construction Program Management: **GPI/CTE Joint Venture**, *New York, NY*
Construction Support Services: **URS Corp. in conjunction with NYCDOT In-House Design and Fabrication Engineering Unit of NYCDOT Quality Assurance**, *New York, NY*
Resident Engineer and Inspection Services: **GPI/CTE Joint Venture**, *New York, NY*
Environmental Compliance: **Environmental Engineering Unit of NYCDOT Quality Assurance**, *New York, NY*
Structural Steel Erector: **Northeast Structural Steel**, *Mt. Vernon, NY*