Marine Parkway Bridge

NEW YORK CITY

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ENGINEERING SOFTWARE
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This $96-million project rehabilitated and enhanced an existing steel-truss bridge that features the world's longest vehicular vertical lift span and was winner of the 1937 AISC Prize Bridge Award. The project widened the existing roadway deck, improving traffic safety and operational efficiency. More than 3000 tons of structural steel were used in the ¾-mile-long project to increase load-carrying capacity and repair deterioration, while continuously maintaining traffic and lift-span operations.

The Marine Parkway Bridge spans Jamaica Bay between the New York City Boroughs of Brooklyn and Queens. The bridge originally was constructed in 1937 to improve access to public beaches on the Rockaway Peninsula. A 150' vertical clearance over a 500'-wide central channel is provided by the record-breaking 540' vertical lift span. Two 540' through-truss spans flank the lift span. A series of deck-truss spans that taper continuously shallower as they approach the shorelines abut each end of the through-truss spans. The deck-truss spans are single-span, two-span and three-span continuous truss units, ranging in length from 98' to 217'. Due to the tapered arrangement, each span and truss member on each deck-truss span is different. The existing bridge, including its deck, had remained essentially unchanged for more than 60 years. The concrete deck needed replacement and the open-curb drainage system was directing runoff off the side of the bridge, causing corrosion of the supporting members below. In addition, road salts had caused the steel-grid deck on the lift span and through-truss span to deteriorate. Approach truss members also had deteriorated from their proximity to the salt water below. Deferred maintenance during times of budget constraint provided short-term savings but eventually took its toll on this bridge. Corrosion-induced section losses coupled with changes in design codes left the Marine Parkway Bridge with a load rating of less than the desired HS-20.

Deck replacement options were studied in the 1990s, followed by design for a bridge reconstruction, including deck replacement, widening, and substantial strengthening and replacement of truss members to meet current design standards. The construction contract was awarded in 1998, but lane closures did not start until fall 1999 to allow for paint removal, shop-drawing preparation and fabrication. Construction was substan-

tially complete on schedule in May 2002, when all four lanes were opened to traffic.

Widening was accomplished by relocating the sidewalk on the west side of the bridge outboard of the trusses. Since the truss geometry only allowed shifting to the west, the spans became eccentrically loaded. The use of lightweight materials minimized the eccentric load effect. Two lanes of traffic had to remain in service at all times, and the vertical lift span had to remain operational without disruption to navigation for the entire construction period. Work also included lead-paint abatement; repainting of the entire structure; seismic upgrade; electrical work associated with span operation and other systems; and decorative lighting for the helical lift-span towers.

CHALLENGES AND SOLUTIONS

Traffic safety improved: The existing bridge had four 11'-wide lanes and no center median barrier. For safety, the bridge operated with two lanes in the peak traffic direction and one lane in the opposite direction, separated by a buffer lane. By moving the single, 6'-wide sidewalk on the west side of the bridge outside of the through-trusses, roadway widening was possible. The reconfigured and widened roadway deck provides four 12' lanes and a continuous median barrier, so two lanes in each direction can be continuously in service. State-of-the-art roadway lighting and a gantry-mounted traffic-lane control system further improved operational safety.

Fast-track completion: Emphasis on constructibility during the design phase and shop fabrication of most components facilitated fast-track construction. Preparation prior to the first lane closures allowed for existing paint removal and identification of previously concealed areas of deterioration and development of repair strategies. Simplified, repetitive details and provisions for fit-up tolerances minimized field problems.

Improve structure strength: One of the project goals was to increase live-load capacity to HS-20. Since considerable extra weight was added to the west side of the span, the west-deck trusses required substantial strengthening. East-deck trusses required strengthening primarily to accommodate deterioration. Fifty percent of the 362 west-deck truss members required repair or replacement, while only 15 percent of the east-deck truss members required repair or replacement.

Provide cost-effective long-term solutions: 90,000 sq. ft of lightweight, precast-concrete deck, and 90,000 sq. ft of grid deck were installed, but the project was more than just a deck replacement. The project corrected 60 years of deterioration and extended the life of the structure. First, the structure was cleaned to bare metal by abrasive blasting and repainted. Steel-repair details were prepared based on inspections before and after paint removal. Primary and secondary members were repaired or replaced after deck removal. With the deck removed, access was simplified, member loads were at a minimum, and repairs and bearing replacement were convenient, with workers and equipment mobilized. The existing seismically vulnerable rocker bearings were replaced with 36 multi-rotational bearings, carrying loads up to 2600 kips. The open roadway curb was eliminated and scuppers were installed to deflect water from the steel and limit future corrosion problems.

Minimize deck weight to limit strengthening requirements for the trusses: The new roadway deck on the deck-truss spans is a lightweight concrete deck, precast on galvanized steel stringers. The panels are supported on steel seats installed on the floor beams. This facilitated speedy construction using waterborne equipment, and minimized the effect of traffic vibrations on the concrete during curing. In addition, the deck panels provided a surface for construction access. The entire deck was overlaid with 1½" of high-performance concrete for a smooth transition between deck panels. The through-truss and lift-span decks remained open grid due to weight restrictions. However, the depth of the grid deck was increased and the purlin spacing was doubled to reduce the overall deck weight. The sidewalk deck consists of a lightweight stiffened steel plate with an epoxy overlay. The parapet on the east fascia was fabricated from steel plate, and the median and west barriers were extruded aluminum shapes. The sidewalk railing also was fabricated from lightweight aluminum shapes. Minimizing the new deck weight allowed the existing trusses to remain in service, and no strengthening of the through-trusses was required.

Cost-effective use of steel: In the design phase, weighing the relative value of materials versus labor was a key concern. The need to keep the bridge open to traffic prevented the replacement of entire spans, and time constraints limited repair options. Shop-fabricated steel-repair plate material was inexpensive, and installation costs and scheduling issues controlled. Thicker repair plates were used to maintain existing rivet spacing while meeting fastener spacing, sealing and stitch requirements without adding intermediate bolts in costly field-drilled holes. Relieving the load in a member prior to adding repair plates would have optimized the material requirements by distributing truss self-weight to both the existing and new steel; but it would have required labor-intensive jacking operations at hundreds of truss members. The repair-plate-thickness increase for the sealing and stitch requirements also achieved the desired load-carrying capacity without jacking the load out of the members. Simplified repair details allowed removal of one quarter of the rivets, one connection at a time, without compromising the load-carrying capacity of the structure. Using these details, multiple crews worked simultaneously on the critical-path truss-member-repair work to meet the tight project schedule.

Selective replacement of main-chord members to improve serviceability: Sixteen members on the deck-truss spans with thin cover plates and wide rivet spacing had significantly more bowing between rivets and impacted rust than other members. Replacing these members minimized future maintenance requirements. Plans were prepared for jacking frames for both tension and compression members to relieve the load and allow replacement of members loaded up to 850 kips in tension or compression. Strains were monitored during the jacking operations to assure loading in the new member was similar to the old. The state-of-the-art jacking operation allowed for safe, efficient replacement of entire members under load.

Needs of the community and travelling public were met: Two lanes of traffic were open at all times using staged construction. Lane closures were limited to a 29-month period, impacting only two summer peak traffic seasons. Contractor access was allowed only from the ends of the bridge and from the water for safety reasons and to prevent disrupting the remaining lanes. Construction was accelerated so that the sidewalk was closed for only one summer, and free bicycle shuttles accommodated cyclists.

Lift span remained operational throughout construction: Coast Guard regulations required that the lift span remain operational throughout construction, which only could occur if it remained properly balanced. Because of the center-of-gravity shift from the westward widening, the lift-span counterweights were modified to shift weight from their east to their west ends. The span balance for each component removed and installed during construction on the lift span was tabulated and daily weight adjustments were made. This maintained a proper balance and prevented overstressing the machinery during span operation. The sheave trunnions were post-tensioned to reduce positive stress ranges under the increased loading and to mitigate fatigue concerns as the span opened. Five-inch-diameter-high strength studs were installed through core holes in all eight counterweight sheave trunnions, and they were loaded by sequential turning of jacking bolts to post-tension them. The contractor designed a paint-removal-containment system for the lift-span towers that could be retracted to allow the span to lift. As a result, marine traffic could pass on demand, unhindered by construction activities.

Signature aesthetics preserved and enhanced: The signature helical towers of the lift span and the three long trusses form a centerpiece for the bridge. The tapering deck-truss spans transition between the main spans and the shores of the bay. Repair details did not affect the visual profile of truss members. The relocated sidewalk has clean simple details and an attractive railing. Decorative lighting illuminates the impressive lift-span towers. ★