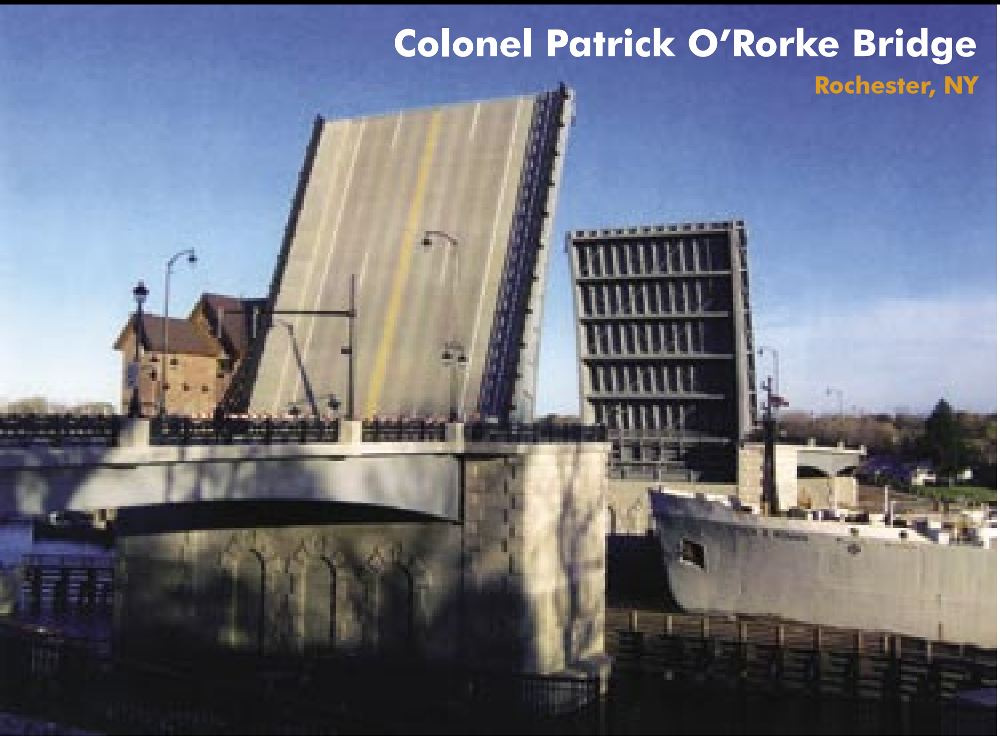
Colonel Patrick O'Rorke Bridge

Rochester, NY



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Owner
New York State Department of Transportation, Rochester, NY

Engineer of Record
Bergmann Associates, Rochester, NY

Engineering Software
DESCUS I, STAAD, Merlin-DASH, FB-Pier, SEISAB

Detailer
Tensor Engineering, Indian Harbour Beach, FL, NSBA/AISC member, NISD member

General Contractor
Crane-Hogan Structural Systems, Inc., Spencerport, NY

After nearly a decade of planning and engineering and four years of construction, the Colonel Patrick O'Rorke Bridge, a replacement bridge for a 72-year-old bascule bridge, was opened to traffic on October 1, 2004. The $104 million bridge, which is located six miles north of Rochester, NY at the confluence of the Genesee River and Lake Ontario, was named in homage to a Rochester native and Civil War hero.

The new bridge consists of a 243'-long bascule span, which is flanked by a 148'-long single-span steel girder approach structure on the west side and a 530'-long, three-span steel girder approach structure on the east side. The bridge, constructed some 250' upstream of the previous bridge, is 22' higher than its predecessor and carries four 11'-wide vehicle lanes, two 5'-wide bicycle lanes, and oversized 7'-wide sidewalks.

Steel was chosen for the primary structural members due to its strength, the depth and length requirements of the main spans, and its ability to easily conform to the shapes needed for aesthetics. The project included more than 2,600 tons of structural steel, five miles of H and pipe piles, and 1.8 million pounds of reinforcement.

Bascule Span

The centerpiece of the O'Rorke Bridge project is a double leaf, Scherzer rolling lift bascule span. Designers selected the rolling lift arrangement because it provided the necessary clear channel opening with approximately 10% less length in the bascule leaf when compared to a trunnion-type bascule bridge.

Steel framing for each leaf consists of two 13'-deep bascule girders with floor beams and stringers supporting a concrete filled steel grating deck. More than 850 tons of structural steel were used for the two bascule leaves alone. In order to minimize the power requirements needed to operate the bridge, the lift spans are counterweighted to produce a balanced condition. The bridge features a closed concrete deck system and requires very large concrete counterweights, each weighing over 590 tons. Heavy structural steel truss frames embedded inside the concrete counterweights transfer the counterweight load to the bascule girders.

Balancing the O'Rorke Bridge lift spans presented a unique challenge. Both the vertical and horizontal location of the center of gravity of the bascule span had to be accurately determined so that the span would remain balanced throughout the full range of movement. Throughout steel fabrication, erection of the bascule steel framing, and concrete counterweight placement, the engineers performed detailed balance computations to account for the exact weight and center of gravity of every component. Additionally, the engineers used strain gage instrumentation to aid in the balancing process. Even with these precise computations, the engineers provided for pockets cast inside the concrete counterweights in which small, concrete balance blocks could be added or subtracted to fine tune the balance.

Approach Structures

Approach structures flank the bascule span on both the east and west sides. On the east side, geotechnical investigations revealed seams of organic materials adjacent to the river channel. Designers chose to span this area with a 530'-long, three-span approach structure founded on steel H-pile foundations to alleviate concerns regarding long-term settlement.

To simplify detailing, fabrication, and erection of the eight steel plate girders that make up this structure, the designers specified radial substructures with each girder being located on combined tangent and compound curve alignment. This eliminated the spiral on the girders but resulted in a variable deck overhang. The compound curves were non-concentric, resulting in a splayed configuration to accommodate the turning lane. The unique geometry required a combination of both X-type and K-type cross-frames (280 total).

A varying depth web on the fascia girders only (from 7' to 13') was chosen for aesthetics to mimic the haunches on the bascule spans and required special cross-frame and lateral bracing connection details, as the interior girders were a constant 7' in depth.

The fascia girders also serve as the live load uplift restraint mechanism for the bascule girders. In order to resist the large, 430 kip uplift forces generated by the bascule span, each fascia girder on the east approach structure is cantilevered 10' into the bascule pier and is detailed to mate with the tail of the bascule girders. The fascia girders are outfitted with specially designed uplift bearings with two 4"-diameter, high-strength steel anchor rods that are embedded over 30' into the wall of the bascule piers.

Bascule Pier Foundations

There is a significant variation in site geology from one side of the river to the other, requiring different foundation systems at each pier. Due to the depth of overburden materials, pile-supported foundations were selected for the eastern bascule pier, which is founded on 114 HP14×117 steel piles, with an average installed length of approximately 100'. A spread footing was selected for the western bascule pier, which is founded on a series of 24 level rock benches, each approximately 12' by 20' with 3' steps between.

The installed foundations at the western bascule pier consist of a 3 by 8 grid of 53"-diameter shafts with permanent steel casings and 48"-diameter rock sockets. The drilled shaft lengths vary from 60' at the deepest part of the foundation footprint to 30' at the shallowest.

Shop and Field Erection

The fabricator and designers worked together to develop and execute a successful numerical roll-through procedure using a system of precise computer controlled milling and measurements of the various components. A field roll-through of the heel sections of the bascule girders was also performed on site to verify the alignment of the track castings and rack girder support frames embedded in the bascule pier concrete.

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Contract provisions prohibited construction activities that blocked the navigation channel for extended periods of time. Rather than erecting the steel from a barge in the middle of the channel, the project team opted for a non-conventional erection plan involving placement of a 500 ton hydraulic crane on the 9"-thick concrete deck of the flanking approach structures when it came time to erect the structural steel for the toe end of the bascule leaves. The lift plan resulted in concentrated outrigger loads of more than 200 kips being transferred to the bridge deck, framing, and supporting piers. The designers and contractors worked together to develop a lift plan using a combination of temporary shoring and heavy steel grillages under the crane outriggers. Stresses on the supporting framing were minimized and no damage occurred to the bridge deck.

Isolation Bearings

Because the flanking approach structure girders serve as the live load restrainers, the approach structure bearings needed to be fixed at the bascule pier. To minimize the seismic forces on the bascule pier, the designers specified innovative fused lead-core rubber isolation bearings at this location. The bearings feature an elastic restraint system (ERS) comprised of overlapping plates attached to the sole plate and masonry plates, which are then fastened together with fuse bolts. Under service loads, the ERS allows the bearing to function as a fixed bearing, preventing longitudinal translation of the structure. Higher forces during a seismic event will shear-off the fuse bolts allowing the eastern approach structure to "float" on the rubber bearings, with the lead core absorbing the earthquake energy. ★