



## The Frederick Douglass – Susan B. Anthony Memorial Bridge

By Samuel Anthony, P.E.

**T**he Frederick Douglass – Susan B. Anthony Memorial Bridge (formerly the Troup Howell Bridge) was a \$41,000,000 replacement project located in Rochester, New York (Figure 1 shows the old Troup Howell bridge). Rochester, with a metropolitan population of about 1.2 million, is situated on the southern shore of Lake Ontario. The Genesee River bisects the city and flows northward to the Lake. The Frederick Douglass – Susan B. Anthony Memorial Bridge carries Interstate 490 over the Genesee River and several city streets and ramps. I-490 is a major commuter route and provides connection from eastern and western suburbs to center city.

*Fireworks display set off at the conclusion of the dedication ceremony July 13, 2007.*

In 1999, New York State Department of Transportation (NYSDOT) commissioned Erdman Anthony to perform a bridge replacement-type study. Six different bridge types were evaluated: short span steel multi-girder, long span steel multi-girder, prestressed concrete box girder, steel box girder, steel through arch and cable stayed. After considering the bridge type options at a public hearing, the community overwhelmingly chose the steel arch. There was consensus on a fundamental point: the site deserved a “Gateway” or “Signature” span that framed the river as well as the City skyline. Given that several multi-span masonry arch bridges are located downstream, it was decided a more modern arch – “but not too modern” – would be the appropriate bridge type. The through arch structure provided aesthetic benefit and allowed the I 490 profile to be lowered about 1 meter (3.2 feet), which partially mitigated a nonstandard I-490 stopping sight distance.

The new eight-span structure is 364 meters (1,194 feet) long. The centerpiece is a 132-meter (433-foot) long through arch span crossing the Genesee River. Most arches built in the last several decades have been of the tied arch style. One benefit of a tied arch is that it does not require a large foundation. In many cases, however, the tie becomes deeper than the arch rib in order to resist arch thrust. When given the choice between a tied arch and a true arch design, the Aesthetics

Committee chose the true arch. Feedback indicated that a thinner deck was more desirable. A true arch requires transmission of thrust to a solid competent foundation, preferably bedrock. Since extremely competent bedrock (i.e., allowable bearing pressure is 1.2 MPa or

### Project Team

*The project team included Erdman Anthony as the prime consulting engineer that managed the project team, performed highway and bridge design and provided construction support services. H2L2 Architects served as the subconsultant moderating the Aesthetics Committee, which consisted of representatives from local city, county and state government, the Arts and Cultural Council, the Landmark Society of Western NY, the Greater Rochester Visitors Association and the American Institute of Architects. High Steel Structures, Inc. fabricated all structural steel for the project, totaling 3,220,000 pounds.*

*Plans, specifications and estimate were completed in June 2003. The bridge construction project was awarded to Edward Kramer and Sons, Inc. in November of 2003 and a ground breaking ceremony was held May 6, 2004.*



Figure 1: The Old Troup Howell Bridge.

12.5 tsf) was located within 4.0 meters (13.1 feet) from ground surface, the choice of a true, two-hinged arch became structurally and economically feasible.

The river is confined at the site by concrete walls along each bank. River walks on both upstream banks had recently been constructed, and it was the City's goal to extend the walkways under the bridge (Figure 2 shows a portion of the river walk which travels under the completed bridge). To allow for construction of the foundations in the dry and for the river walks, the span was set at 132.0 meters (433.0 feet).

In the bridge section, it was necessary to increase median shoulder widths to meet standards, so it also became necessary to further separate the I-490 eastbound and westbound alignments. The amount of separation, however, had to be kept to a minimum owing to the presence of structures located on the edges of both approaches. The historic Corn Hill neighborhood (Figure 3, page 36 shows a view of the completed bridge from Corn Hill Landing) and the Public Safety building are present on the west side, and bridge piers for an overhead ramp bridge are on the east side. These constrictions precluded the use of four-arch ribs; two supporting each travelway, which is the common arrangement for bridges of this type. In the end, it was decided to support both eastbound and westbound travelways by only three ribs. Precedent for three-rib construction was found in Berlin, Germany with the Arch Bridge over the Britz Canal, opened to traffic in 2001.

Ribs for the Troup Howell Bridge are steel boxes. The center rib is 3.000 by 1.170 meters (9.8 by 3.8 feet) and the exterior rib is 1.780 by 1.170 meters (5.8 by 3.8 feet). They are spaced at 19.9 meters (65.3 feet). The boxes are made with a wider top flange than bottom, and aesthetic stiffener plates are added at each hanger location. This overhang geometry provides the illusion of a trapezoid and promotes the creation of shadows, which enhances visual interest.

The arch rib bracing is Vierendeel type to maximize the view to open sky. Six brace lines connect the ribs. The braces are also steel boxes and are dog bone shaped in plan view. The braces are also used to support expressway lighting. Fixtures are mounted within bottom flange penetrations at each brace. This arrangement eliminates the need for conventional lighting poles mounted on the bridge deck, which the Aesthetics Committee believed would visually conflict with the hanger layout.

Rather than vertical hangers, a fan shape orientation was preferred as seen from the elevation. A small tie (i.e., C 380 x 50 or C15 x 33.9 channels oriented back to back) was added at deck level to resist the horizontal hanger component resulting from this arrangement. The tie extends from first to last hanger and does not connect to the rib. As a result, the arch thrust will still be carried by the foundation. Subsequent to structural analysis, it was determined that the fan orientation not only provided visual interest but also was beneficial in transmitting longitudinal earthquake load from deck level, back to rib, and then down to foundation. Two structural strand hangers are provided at each of the 19 panel points for redundancy.

Since a design goal was to carry the river walks beneath the bridge, the underside of the bridge would be exposed to the public. The Aesthetics Committee asked if the floorbeams could be modified to provide visual interest for pedestrians. The design team's solution was the use of rounded floorbeam ends and a sculpted floorbeam with variable depth. The floorbeam depth was made shallowest at hanger points and deeper between. The final shape not only met the desire for visual interest, but proved structurally efficient for handling shear and bending stresses. All nineteen floorbeams were detailed with similar shape. The rounded floorbeam end also serves to house aesthetic lighting that, at night, shines upward along the hangers and illuminates the underside of the arches and braces.

Another request was a bridge railing system that would allow views of the surrounding area by passengers in I-490 vehicles. The railing detailed for this part of the bridge contains two steel tubular rails at the top of the concrete barriers that permit viewing. The railings are based on a design for a Pennsylvania Department of Transportation (PENNDOT) arch bridge in Pittsburgh; the PENNDOT design was found to be Interstate compliant and given recent FHWA approval. This system is used for the first time in New York State on the Frederick Douglass – Susan B. Anthony Memorial Bridge.

*continued on next page*



Figure 2: The New Frederick Douglass - Susan B. Anthony Memorial Bridge.



Figure 3: A Picturesque View of the Bridge from Corn Hill Landing.

The bridge steel is painted with the standard New York State three-coat system: inorganic zinc primer, epoxy intermediate coat and polyurethane final coat. The final coat on the arch ribs, braces and hanger plates is silver and the framing below the deck is reddish brown. The community had a direct impact on paint color selection. During the neighboring Corn Hill summer festival that usually draws about 100,000 attendees, the design team set up an exhibitor's booth and invited the community to vote on a bridge paint color. The results of this vote were the basis of the final bridge color choices.

A major project challenge was to detail the plans for staged construction. The I-490 corridor carries about 50,000 average daily traffic (ADT) in each direction. Traffic modeling indicated that a bridge closure was not an option without gridlock on city streets, so staged construction was pursued. The plans called for construction

in three stages. Stage I allowed construction of the majority of new foundations beneath the existing bridge. By locating new substructure elements where none existed, more construction could be accomplished without disruption to I 490 traffic. Stage II required the demolition and replacement of the eastbound bridge. In this stage, all I-490 traffic was shifted to the westbound side and the number of lanes reduced from 3 thru lanes to 2 in each direction. At the conclusion of Stage II, all I-490 traffic was shifted to the new eastbound bridge (i.e., 2 lanes in each direction). During Stage III, the westbound side was demolished and rebuilt.

Rochester Mayor Robert Duffy held a dedication ceremony at construction completion on July 13, 2007, officially changing the name of the bridge from Troup Howell to the Frederick Douglass – Susan B. Anthony Memorial Bridge. The bridge has won awards, including the 2007 Merit Award from the National Steel Bridge Alliance and the 2007 Project of the Year Award from *New York Construction Magazine*. Rochester's *City Magazine's* annual "Best of 2007" issue featured the bridge as the Best Use of Public Funds. ■

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