Replacement Bridge Key to Station Modernization

Micropiles are used to support the foundations of a new bridge.

By Dave Stahnke

Having turned 100, the Arch Street Bridge was showing its age. The bridge, which carries four Northeast Rail Corridor tracks over Arch Street in Greenwich, CT, is a major connector road between I-95, just south of the bridge, and the central business district of Greenwich to the north. On average, 215 trains cross the span each day.

The Connecticut Department of Transportation (CTDOT) determined that the bridge should be replaced as part of an overall modernization program that also included the rail platforms, station upgrading, and a new pedestrian overpass. Selected by CTDOT to design the project, URS Corporation (www.urscorp.com) focused on five major objectives:

- Replace the substandard, non-redundant steel girder railroad bridge, which supports heavy Metro-North and Amtrak train traffic.
- Extend the elevated pedestrian platforms over Arch Street to allow for the boarding and debarking of ten passenger train cars. Previously, only eight cars could open doors on the platforms.
- Widen Arch Street from the I-95 ramps north to the intersection with Soundview Avenue to improve traffic operations and provide safer pedestrian movement. The existing railroad bridge, due to its short span, created a bottleneck and impeded traffic along Arch Street. Traffic often would back up onto I-95 from the southbound off-ramp as a result of congestion on Arch Street.
- Provide new stair structures to access the extended pedestrian platforms along the west side of Arch Street, where the major long-term station parking is located. New stair structures will allow pedestrians to access the train station and platforms without crossing Arch Street.
- Upgrade the Greenwich train station to make it ADA compliant. Upgrades include an elevated pedestrian bridge with stair structures and elevators to provide access between inbound and outbound platforms; pedestrian shelters on the elevated platform; tactile warning strips along the edge of platforms; ADA compliant pass-through ticket drawer, telephone, drinking fountain, and signage throughout the station and platforms; and improved lighting and a new public address system.

Arch Street and the Arch Street Bridge before construction.

Replacement Bridge

The new Arch Street Bridge is a 100-ft simple span steel plate girder structure with a composite 13-in. thick reinforced concrete ballasted deck with membrane waterproofing. The principal challenge confronting designers was to replace the existing bridge while maintaining heavy railroad traffic on the bridge and vehicular and pedestrian traffic beneath it. It was also necessary to increase the span of the bridge by 40 ft to allow the construction of additional traffic lanes on Arch Street.

To meet the challenge, URS developed an innovative technique of utilizing micropiles to support the foundations of the new bridge and top-down

construction techniques to accommodate the widening and replacement of the bridge while maintaining traffic. A micropile is a small diameter high capacity pile that is constructed like a small drilled shaft. A steel casing is advanced into the ground and/or bedrock, the soil is removed, a center steel reinforcing rod is placed, and high strength grout is pumped into the casing. The mircopiles on the Arch Street Bridge project have a maximum capacity of 80 tons and are only 8 5/8 in. in diameter. The micro-piles on the Arch Street Bridge project were installed by GZA Drilling Inc. (www.gza.com).

For the east abutment, micropiles were drilled through the existing bridge stem, and a new bridge seat and backwall were cast on top to support the new superstructure. The lower portion of the existing abutment wall remained in place to support the backfill loads. All new heavier superstructure loads are carried by the micropiles down to the subsoil. The new west abutment was constructed 40 ft in back of the existing abutment. This was accomplished by installing micropiles to support a new stub abutment, which in turn supports the new superstructure.

The construction was performed in four stages with no more than a single track out of service at any time. When the superstructure was completed, all four tracks were put back into service. The excavation was carried out below the bridge by using soldier pile and lagging (top-down) construction techniques. A permanent cast-in-place concrete fascia wall was installed onto the soldier pile and lagging to complete the appearance of a full-height abutment.

All exposed new concrete surfaces were cast with architectural formliner and stained to match the appearance of the existing brownstone block bridge abutments. Due to varying bedrock depth, the west abutment micropiles are supported in soil while those to the east are supported in rock. All micropiles are designed for a maximum load of 80 tons in compression and 20 tons in tension.

Erection of the pedestrian bridge.

New Arch Street Bridge with pedestrian platform.

New pedestrian bridge with elevator tower.

Arch Street was reconstructed for a total length of 1,000 ft from its intersection with I-95 south of the bridge to its intersection with Soundview Drive to the north. The existing bridge had been inadequate to accommodate the 26,800 vehicles that use the facility each day. Arch Street was widened to contain two through-lanes, one northbound and one southbound, passing under the bridge, along with an exclusive left-hand northbound turning lane at two key intersections. In addition, new traffic signals were installed at the two intersections, along with new signage and pavement markings.

New stair structure.

Pedestrian Bridge Design

A new elevated pedestrian bridge with elevators and stairs was constructed to provide access between the inbound and outbound platforms. The superstructure consisted of a Vierendeel truss structure with composite concrete floor deck, steel framed roof with batten seam metal roofing, and sides enclosed with a curtain wall window system. A Vierendeel truss is a truss without diagonal members. This type of truss is used frequently for pedestrian bridges where the diagonal members cannot interfere with the glass side walls. From a purely structural point of view, a Vierendeel truss is really a steel frame.

The entire superstructure, which included steel tube framing, was designed so it could be totally fabricated on the ground adjacent to the bridge's permanent location and was constructed in an adjacent parking lot. The sidewall trusses and the roof system, floor system, and window frames also were constructed on the ground.

The pedestrian bridge spans 61 ft between platforms and provides 22 ft, nine in. of minimum clearance over the train tracks. The support elevator and stair towers at each platform also are framed with steel tubes and are supported on reinforced concrete foundations on micropiles. The walls are infilled with concrete block and brick veneer. All steel is galvanized and painted a dark green to match other public works and facilities in Greenwich.

Measures were taken to limit inconvenience to passengers. During a brief nighttime track closure, the superstructure was lifted by a large-capacity crane up and over the electrical power lines and set down on steel supports. This construction technique assured minimal interruption of rail service. The use of high-capacity cranes and lifting of large portions of new bridge superstructures is being promoted by the Federal Highway Administration as a way to minimize traffic disruption during construction.

The existing pedestrian platforms over Arch Street were extended to allow the full boarding and debarking of ten Metro-North passenger trains at the Greenwich train station. Each platform extension consists of a pair of rolled steel beams composite with an eight-in. thick reinforced concrete deck slab and outside concrete parapet. A decorative five-ft high protective fence was mounted on the outside parapets. The wearing surface consists of a polymer mortar topping. Platform lighting also was extended over Arch Street.

The completion of the new bridge and the widening of Arch Street have resulted in a fully modernized railroad station that is more easily accessible to passengers, safer for motorists and pedestrians, and an aesthetic asset for the community. GE

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