Lichtenstein Medal Award Nomination

Frankford Avenue Bridge over Pennypack Creek
Philadelphia, Pennsylvania

EXECUTIVE SUMMARY

Frankford Avenue crosses the Pennypack Creek, in the northeast section of Philadelphia, Pennsylvania with a three span, closed spandrel, stone masonry arch bridge, and is the oldest continuously used roadway bridge in the United States. Constructed in 1697, this engineering landmark has undergone many construction and repair campaigns throughout the last three centuries, but it still remains true to its original form. The bridge has two 25'-0" spans and one 12'-9" span for a total length of 73'-0" and a barrel width of 44'-0". The bridge features two 12-0"' traffic lanes (one in each direction), 6'-0" shoulders, and a sidewalk on each side.

The rehabilitation program scope of work included in-kind reconstruction of the spandrel walls and wingwalls, in particular the original (1697) north spandrel wall that exhibited bulging and the portions of the wall that sustained collision damage. The architectural features that were present on the bridge prior to rebuilding were maintained. Cleaning, repairing and repointing of the stone masonry occurred throughout. The earth fill between the two spandrel walls and beneath the roadway was replaced with lightweight concrete fill. The sidewalks were reconstructed in-kind and a new crashworthy roadway barrier was sympathetically detailed and built between the sidewalk and the roadway. The existing decorative pedestrian railing was salvaged, repaired, painted brown and reinstalled on the new sidewalk overhangs. The concrete arch liners were repaired and sealed.

One of the largest challenges to overcome during construction was making sure that the masons on the project had the right combination of experience and desire to perform quality work with the utmost attention to detail. The masons selected by the contractor performed high-quality construction, faithful to the original in methodology, workmanship and detail. They followed stringent specifications on mortar color and composition and pointing style and size of joints. They had to dismantle the spandrel walls, clean the existing stones and then reuse them on the rebuilt wall. Because structural integrity was paramount on this workhorse bridge, they did not match-mark and reset the existing stones exactly, but maintained the overall look and feel of the original structure. Several of the arch barrel stones, which were cracked and falling from the structure, had to be expertly repaired to maintain the bridge's look and integrity.

During the removal of the existing earth fill from the arches, a very interesting and noteworthy discovery was found. The original south spandrel wall was uncovered intact as well as a previously unknown diaphragm wall. This finding permitted the details of the original 1697 construction to be memorialized through detailed measurements and photographic documentation. The diaphragm wall was a feature not previously seen in the masonry arch bridges of the region and speaks volumes to the knowledge and craftsmanship of the local residents who built the bridge.

The rehabilitation of the Frankford Avenue Bridge, through the use of sensitive rehabilitation methods, attention to detail, and collaboration between the owner, designer, contractor and the community, will serve as a prominent model for future stone masonry arch rehabilitations. It will also continue to serve as a lasting symbol to the community and as a true engineering landmark in the history of American transportation.

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Frankford Avenue Bridge over Pennypack Creek
Philadelphia, Pennsylvania

Overview

Frankford Avenue crosses the Pennypack Creek in the Holmesburg neighborhood, in the northeast section of Philadelphia, Pennsylvania with a three span, closed spandrel, stone masonry arch bridge, that unbeknownst to many, is the oldest continuously used roadway bridge in the United States of America. Constructed in 1697, this engineering landmark has undergone many construction and repair campaigns throughout the last three centuries, but it still remains true to its original form.

Continued deterioration and recent collision damage necessitated that a rehabilitation program be developed to preserve the Frankford Avenue Bridge by PennDOT, in conjunction with Transystems. The intent of the program was to sensitively address the bridge's structural deficiencies while maintaining its historic character. To do this, the bridge was partially dismantled and reconstructed in-kind using as much existing material as possible, while maintaining existing dimensions. The program also included rehabilitation of a stone masonry culvert, over a former mill race, located adjacent to the bridge.

PennDOT Engineering District 6-0 (District 6-0) has a strong historic bridge rehabilitation program - they view their historic bridges as irreplaceable assets and make every effort to rehabilitate and preserve them. As part of their commitment to historic bridge rehabilitation, District 6-0 has developed a management plan and maintenance manual for their stone arch bridge population. The rehabilitation program developed for Frankford Avenue Bridge follows the recommendations and methodologies laid out in the management plan and maintenance manual in addition to following The Secretary of the Interior's Standards for the Treatment of Historic Properties and Guidelines for Rehabilitating Historic Buildings.

Historical Significance

Listed on the National Register of Historic Places in 1988, the Frankford Avenue Bridge over Pennypack Creek, also called the Pennypack Creek Bridge, is significant for its engineering and transportation history.

The Frankford Avenue Bridge was built in 1697 by residents of Lower Dublin Township who were given the choice to assist with construction or pay a tax. Pennypack Creek was not affected by changing tides from the Delaware River (and the Atlantic Ocean) in this area and the route was originally a trail used by Native Americans and later Dutch and Swiss settlers. This trail was incorporated into the King's Highway, which became a regularly traveled route between Philadelphia, PA and Frankford, PA by 1725 and extended to Boston, MA by the end of the eighteenth century. It ultimately connected the colonies from New England to the Carolinas. Delegates crossed the Frankford Avenue Bridge on their way to draft the Declaration of

Independence in 1776 and later when traveling to draft the United States Constitution. The road remained unpaved during this time.

In 1803, the Frankford and Bristol Turnpike Company paved across the Frankford Avenue Bridge as part of a toll road that extended from Philadelphia to Morrisville, PA. A major flood in the 1860's topped the roadway and flooded the mill race, causing a major crack in the center of the arch barrel and closed the bridge for days. At some point during this time, tie rods attached to 2 foot long plates were installed on either side of the bridge to prevent further separation of the spandrel walls. The road served mainly horse and buggy traffic throughout the nineteenth century until the section of the Turnpike surrounding the bridge was sold to the City of Philadelphia in 1892. Due to phenomenal population growth in northern Philadelphia, the bridge was widened in 1893 to accommodate a trolley line.

The 1893 widening of the bridge included increasing the out-to-out width from 22 feet to 44 feet by widening the bridge to the south, raising the roadway profile, rebuilding the parapet walls topped with crenellated stones, and widening the culvert over the mill race. Automobiles were sharing the road by 1915 and the trolleys were replaced with buses by 1955. In the twentieth century, the crenellated parapets were removed from over the creek and replaced with overhanging sidewalks with decorative pedestrian railings, and reinforced concrete arch liners were constructed under the original portion of each arch barrel (north side).

Bridge Description

The Frankford Avenue Bridge has two 25 foot clear spans and one 12'-9" clear span for a total length of 73 feet from face to face of abutments. The total length of the structure, from end to end of the north masonry retaining walls is 450 feet. The arch barrel is 44 feet wide and supports two 12 foot traffic lanes (one in each direction), 6 foot shoulders, and a sidewalk on each side. The bituminous roadway was supported on earth fill and contained by approximately 3 foot thick masonry spandrel walls. Numerous utilities are buried in the earth fill including a 36 inch diameter sewer line, a gas line, a water line and several communications duct banks. The north sidewalk featured a variable width concrete slab overhang, ranging from 0" to 24" with a decorative pedestrian railing. The south sidewalk was a concrete filled metal grid supported on floorbeams and stringers that were embedded in a concrete cap on top of the south spandrel wall. The south sidewalk also had a decorative pedestrian railing. On both sides of the roadway, the sidewalk width was reduced by the presence of a steel bridge barrier.

The culvert to the west of the Frankford Avenue Bridge is a single-span stone masonry arch. The culvert is comprised of three sections. The original 12 foot wide portion was constructed circa 1697 overtop a mill race for the Dale-Sanders Mill which was located on the west side of Pennypack Creek and downstream of the Frankford Avenue Bridge. It was widened 25 feet to the

north at some time prior to 1861 and widened 16 feet to the south during the 1893 bridge widening campaign. Stone masonry parapet walls with crenellated tops are located behind 6 foot wide sidewalks on either side of the roadway. The mill race carried water to the mill (destroyed by fire in 1880) and later to Summerdale Dye Works (in operation until the early 1970s). The mill race is dry and the absence of flowing water has allowed the race to infill with dirt, detritus and vegetation.

Rehabilitation Program

An in-depth inspection was performed by TranSystems during the development of the rehabilitation program. The original (1697) north spandrel wall exhibited the most significant deterioration found at the bridge including areas of water infiltration that was the cause of mortar cracking, mortar loss and bulging of the stone. The water seepage also caused spalling of the concrete arch liners, which exposed the reinforcement bars in some locations. The south sidewalk, which was a concrete filled steel grid, exhibited pack rust to the grid that contributed to the sidewalk bowing upward. The non-standard bridge barriers were rusted and had holes through the bottom rail and an area of minor collision damage.

The rehabilitation program scope of work included in-kind reconstruction of the spandrel walls and wingwalls, in particular the north spandrel wall that exhibited bulging and the portions of the wall that sustained collision damage. The architectural features that were present on the bridge prior to rebuilding were maintained. Cleaning, repairing and repointing of the stone masonry occurred throughout. The earth fill between the two spandrel walls and beneath the roadway was replaced with lightweight concrete fill. The sidewalks were reconstructed in-kind and a new crashworthy roadway barrier was built between the sidewalk and the roadway. The new roadway barrier is constructed integrally with 8 foot wide and 12” thick reinforced concrete moment slabs that sit on top of the lightweight concrete fill. The existing decorative pedestrian railing was salvaged, repaired, painted brown and reinstalled on the new sidewalk overhangs. The concrete arch liners were repaired and scour protection measures were placed around the abutments and piers. Roadway work included milling and resurfacing the approaches, approach sidewalk replacement, and inlet repair. A bituminous overlay was placed from curb to curb. The scope of work for the culvert included stone masonry cleaning and repointing and in-kind reconstruction of the wall end that sustained collision damage.

Project Challenges

One of the largest challenges to overcome during construction was making sure that the masons on the project had the right combination of experience and desire to perform quality work with the utmost attention to detail. The masons selected by the contractor performed high-quality construction, faithful to the original in methodology, workmanship and detail. They followed stringent specifications on mortar color and composition and pointing style and size of joints. They

had to dismantle the spandrel walls, clean the existing stones and then reuse them on the rebuilt wall. Because structural integrity was paramount on this workhorse bridge, they did not match-mark and reset the existing stones exactly, but maintained the overall look and feel of the original structure. Several of the arch barrel stones, which were cracked and falling from the structure, had to be expertly repaired to maintain the bridge's look and integrity.

Due to the numerous utilities that needed to be accommodated on the structure, a special utility bay was created. The majority of the utilities were relocated to the center 20 foot wide area of the bridge and set in earth fill that was topped with a standard unreinforced concrete pavement section. The intent was to locate the utilities where future maintenance activities could be performed without effecting the structural integrity of the concrete fill or moment slabs.

Unique Activities

During the removal of the existing earth fill from the arches, a very interesting and noteworthy discovery was found. The original south spandrel wall was uncovered intact as well as a previously unknown diaphragm wall. This finding permitted the details of the original 1697 construction to be memorialized through detailed measurements and photographic documentation. The diaphragm wall was a feature not previously seen in the masonry arch bridges of the region and speaks volumes to the knowledge and craftsmanship of the local residents who built the bridge.

Community Impact

Rehabilitation of the Frankford Avenue Bridge had a huge impact on the community and the local economy. Frankford Avenue is a major arterial thru the community with approximately 15,000 vehicles crossing the bridge a day in addition to school children on foot and riding the SEPTA trackless trolley that crosses the bridge. There are several schools within ¼ of a mile of the bridge and extensive coordination with the local community, public officials, SEPTA and the schools was required to provide all users safe passage to their schools. The bridge was closed on March 26, 2018 and reopened on September 7, 2018, with the majority of construction occurring during the summer months when school was not in session.

Stone Arch Rehabilitation Model

The rehabilitation of the Frankford Avenue Bridge, through the use of sensitive rehabilitation methods, attention to detail, and collaboration between the owner, designer, contractor and the community, will serve as a prominent model for future stone masonry arch rehabilitations. It will also continue to serve as a lasting symbol to the community and as a true engineering landmark in the history of American transportation.