AMERICAN PUBLIC WORKS ASSOCIATION
PUBLIC WORKS PROJECT OF THE YEAR AWARD

Tacoma Avenue South Bridge

Nominated for: Historical Restoration/Preservation Less Than $25 Million

City of Tacoma
WASHINGTON

2018 APWA PROFESSIONAL AWARDS

Nomination Summary

Tacoma Avenue South Bridge is a 5 span 333-foot long and 52-foot wide steel girder/frame bridge structure in the heart of the City of Tacoma. The bridge was built in 1930 spanning over two active modes of traffic in South Tacoma Way and Northern Pacific Railway. The original bridge was built strong as it was designed for an 8-axle 96,000 pound street car. Yet, the bridge had experienced local heavy corrosion and its cantilevered sidewalks were yielding to the degree that both sidewalks were closed to pedestrian traffic. Due to seismic events, the bridge's south abutment had settled by 8 inches and moved laterally by 4 inches towards the north in such a way that it had cracked the south abutment back wall from its collision with the bridge's steel girders.

Tacoma Avenue South Bridge, 1930

Project vicinity map

As part of the new bridge rehabilitation, the bridge was widened to 59-feet with a new light weight concrete deck and was rehabilitated for both vertical and lateral loads.

Although not listed on the State's historic bridge register, the bridge is considered historic in Tacoma and overlooks the historic Holy Rosary Church at its south approach. The essence of the church's cathedral pillars is captured in the new bridge railing.

Project Introduction

The Tacoma Avenue South Bridge carries the Tacoma Avenue South roadway facility — a vital north-south link within the City's central business district (CBD) with an average daily traffic in excess of 10,000 vehicles.

The bridge was constructed in 1930 as a 5-span (71':28':91':28':94'), 312-foot long, and 52-foot wide steel girder bridge spanning over the two active modes of traffic of South Tacoma Way roadway and Northern Pacific Railway (currently used by Sound Transit).

Construction of the original bridge

The bridge overlooks a historic century old building in Holy Rosary Church located at its south approach.

The original bridge was built strong as it was designed for an AASHO Class AA Loading 8-axle Streetcar with a total weight of 96,000 pounds. Yet, the bridge had experienced heavy localized corrosion and its cantilevered sidewalks were yielding to the degree that both sidewalks were closed to pedestrian traffic.

After securing a federal grant for rehabilitation of this bridge, the City of Tacoma selected and tasked TranTech's team to prepare construction documents and provide engineering support services during construction on this major challenging steel bridge rehabilitation.

The rehabilitated bridge is 59-feet wide with a new light weight deck, new exterior steel girders, and new paint.

The following are some of the unique and innovative aspects of this rehabilitation design:

- Utilization of light weight concrete for deck construction.
- A rehabilitation design that improved seismic resistance of the bridge.
- Widened sidewalk through an outrigger system
- Incorporation of an aesthetic railing that complemented the bridge surroundings
- Removal of all bridge corrosion damages and painting the bridge for longevity


Construction of the south abutment

The City of Tacoma undertook an effective communication dialogue with the project stakeholders, including neighborhood organizations, to ensure that their expectations were met. One major fruit of this labor was incorporation of aesthetic pillars in the bridge's railing that resembled the architecture of the historic century old Holy Rosary Church located at the south approach of the bridge.

__Bridge construction complexities:__

The bridge construction complexities were:

- Construction over two active modes of traffic in Sound Transit railway and South Tacoma Way.
- Repairs on fracture critical elements of the bridge, like steel cap beams.
- Matching existing complex geometry conditions of the bridge.
- Repairing the damages caused by prior seismic events.


Aerial view of bridge after project completion looking east

Project data:

Total project budget: $11.9M

Total actual project cost: $11.9M

Design cost: $1.6M

Scheduled date of completion: July 2016

Actual date of completion: October 2016

Role of other design team members:

GeoEngineers, Inc.: geotechnical engineering

Makers Architecture, Inc.: aesthetics

Transpo Group, Inc.: traffic engineering

MCR Logistics: railroad coordination

Shearer Design, LLC: bridge inspection and load rating

Ott Constructability: constructability and estimation

Murray, Smith & Associates: utilities coordination

Whiteshield, Inc.: surveying

City of Tacoma Water: waterline

In the following sections we have addressed the selection criteria topics:

1. **Use of good construction management techniques and completion of the project on schedule**

   Below is a timeline of the construction schedule for the Tacoma Avenue South Bridge project with relevant dates.

   - Construction start date (commence working days): 1/5/15
   - Contract working days: 320
   - Contract completion date: 4/15/16
   - Working days added to the contract due to various change orders: 13
   - Total revised working days: 333.
   - Substantial completion date (bridge and roadways re-opened to public): 6/16/16.
   - Physical completion date (actual ending date): 10/18/16.
   - Working days remaining on contract: 6
   - Total working days at ending date: 327

The planned Baseline Ending Date was exceeded due to Change Order work added to the Contract and unworkable days granted during construction for seasonal weather affecting critical path work.

City of Tacoma provided the Construction Management for the project and their experienced staff worked successfully with the Contractor, Quigg Brothers Construction (Quigg), in a collaborative environment with good documentation and addressing issues on a timely manner on this challenging project. The project inherited many challenges like corroded steel elements that were hidden prior to the deck removal. Despite these challenges, the construction team was able to finish the project with only 7 actual additional working days.

A significant construction management technique that was utilized was the use of a full-length work platform for the duration of the construction that not only allowed simultaneous work on different sections of the bridge but also made the inspection work streamlined. This cost saving techniques also saved construction time.

Moreover, the new rehabilitated bridge with its new lightweight deck will provide a low-maintenance bridge structure for the City that will serve its citizens for many years to come.

2. Safety performance and demonstrated awareness of the need for a good overall safety program during construction.

Quigg and its subcontractors implemented a site specific safety program for this project to address numerous hazards including:

- Fall protection
- Aerial platform usage
- Work over two active modes of traffic, namely; South Tacoma Way and Sound Transit railway
- The paint subcontractor, Purcell, implemented lead exposure protection safety program by providing effective confinement on all the areas subject to active painting activities and having staff with respiratory protection equipment and clothing.

A hanging platform was suspended below the bridge deck and was engineered to for the construction and painting equipment loadings. This platform served as the Contractor’s access to repairing corroded steel areas.

It also acted as a base for a containment system to prevent broken pieces of concrete, steel, equipment and paint residue from dropping onto the active modes of traffic below.

Bridge deck removed, south abutment wall removed, work deck can been seen under the girders

Safety meetings were conducted weekly to discuss hazards and training was conducted as needed for specific subjects. The project included approximately 3,000 man hours and resulted in zero (0) time lost to accidents or injuries.

This statistic is a credit to the prime contractor, who was able to manage multiple tasks and crews working simultaneously in difficult conditions. These difficult conditions included work over two active modes of traffic, restricted space for under deck work and working at night for girder erections.

Safety and accident prevention program included the following components.

- Accident prevention program
- Project management and emergency contact information
- Safety and health rules, regulations, and policies posted and observed
- Personnel protective equipment
- Medical and emergency response information
- Incident reporting procedures
- Subcontractor safety requirements
- Site-specific requirements
- Project-specific requirements
- Traffic control plan
- Public protection plan

Construction during night time

3. Community relations as evidenced by efforts to minimize public inconvenience due to construction, safety precautions to protect public lives and property, provision of observation areas, guided tours, or other means of improving relations between the agency and the public.

The City of Tacoma Public Works Department embarked on an aggressive outreach to the adjoining neighborhood and all stakeholders regarding the rehabilitation of this bridge. Public Works met with many of these stakeholders including: Hillside Development Council, Jennie Reed Neighbors, Lincoln South Neighborhood Council, Lincoln West Neighborhood Council, Dometop Neighborhood Alliance, and the Whitman Area Neighborhood Council. At each meeting Public Works presented the project and explained the schedule for the bridge closure and answered many questions.

Public Works also contacted Lincoln High School and Holy Rosary Elementary School and provided them with project information and staff contacts.

The Tacoma Avenue South Bridge serves the Lincoln District which is a multi-cultural region in Tacoma. To improve our outreach to this area Tacoma published and distributed an informational flyer in Vietnamese, Cambodian, and Spanish languages. The feedback from the District was that people were very appreciative of the communication.

Public Works also kept an extensive email listing of all of these groups. Emails were published on a regular basis to keep people informed of the bridge progress and updates on the schedule. This email system was an effective tool for keeping people informed and provided a conduit for questions regarding the bridge project.

Ribbon cutting ceremony: PW Dir. Kurtis Kingsolver, CM Ryan Mello, Mayor Marilyn Strickland, CM Victoria Woodards, Dir LP Kathleen Davis

In effort to minimize the impact of the bridge closure to pedestrians and bicyclists, a temporary shared use path was constructed over private property to a parallel street. This 10-foot wide path was paved with asphalt, provided with lighting and constructed to ADA standards. This non-motorized path was in continuous use throughout the project’s construction phase.

To accommodate local traffic the new exterior steel girders were installed at night. Every precaution was undertaken to ensure successful installation of the 7-foot deep girders that were up to 90-feet long. The result was successful installation of all exterior girders of the bridge with minimal impacts to a major arterial street and a transit rail line located under the bridge.

Moreover, the City undertook an effective communication with the neighborhood to ensure that their expectations were met, like incorporating aesthetic features in the bridge structure that resembled the architecture of the Holy Rosary Church. As one citizen commented at the grand opening day of the bridge; “Holy Rosary Church is a defining structure to this bridge and the City did a wonderful job in capturing the essence of the church’s architecture in the rehabilitated bridge structure. Now the bridge and the church look seamlessly compatible and beautiful”.

Through this rehabilitation, the bridge safety was improved for all modes of traffic, including pedestrian and bike. The widened sidewalk is now safely used by pedestrians that include many students from the nearby school.

4. Demonstrated awareness for the need to protect the environment during the project. This includes any special considerations given to particular environmental concerns raised during the course of the project.

Prior to beginning work, the contractor prepared a Stormwater Pollution Prevention Plan (SWPPP) as part of the Temporary Erosion and Sediment Control Plan (TESC), meeting the requirements of the Department of Ecology’s Stormwater Management Manual for Western Washington Volume II – Construction Stormwater Pollution Prevention, and the Department of Ecology’s Construction Stormwater General Permit. The project specific National Pollutant Discharge Elimination System (NPDES) Construction Permit was included in the SWPPP.

Bridge during construction looking south

The Tacoma Avenue South Bridge does not overcross any sensitive wetland or body of water but the bridge was used as a safe-haven for many transients with the areas around and under the bridge filled with bio-hazard litterings. First, the bio-hazard material was cleaned from the area and then the areas under the bridge were overlaid with shotcrete to produce a clean environment.

The removal of the existing lead-based paint was accomplished with full enclosure of the work. The hazardous paint residue was contained and shipped to an appropriate disposal site.

Also, for other construction activities that potentially may have caused environmental damages, the contractor isolated the work areas as much as possible with various containment structures and collected and hauled away the residue to landfills. The construction goal was zero-residue to escape to nature.

5. **Unusual accomplishments under adverse conditions, including but not limited to, age or condition of the facility, adverse weather, soil or other site conditions over which there is no control.**

This challenging project had many unusual accomplishments under adverse conditions, the following are a summary of the major ones:

First, due to prior seismic events, Pier 1 abutment had settled vertically by 8 inches and had laterally moved toward the north by 4 inches. The vertical settlement had created a hump at Pier 2 and the lateral movement to the north had caused the steel girders to move and crash into south abutment backwall, causing major cracks and spalling of the wall.

To compensate for the vertical drop, the south bridge abutment had to be demolished and rebuilt to the original elevations. To accomplish this, the contractor first removed the existing frozen rocker bearings at the south abutment and replaced them with a series of 20-ton jacking systems. Then the girder ends at abutment 1 were jacked up by approximately 8” and temporary supports were installed.

All the vertical jacking activities were monitored by field engineers to ensure that not only excessive loads are not applied to the structure but also any accumulation of internal strains in the superstructure is prevented. This monitoring was in the form of keeping all of the jacking relative displacements to within ¼”. All the vertical jacking operations proceeded as predicted and in fact after the completion of these activities, the rotation of span 1 and its caused hump at Pier 2 was completely eliminated.

The lateral movement of the bridge toward the north had caused the expansion joint at Pier 4 to be completely closed. To compensate for this damage, horizontal jacking was performed at the internal expansion joint at Pier 4 where the bridge superstructure was pushed back toward south. This operation was stopped following the attainment of a reasonable bridge push-back.

Second, the steel girders spanning the old Northern Pacific Railway had a carbonaceous fire-proof coating of up to ¾” thick. This layer not only was preventing the application of an effective paint system on the steel girders of Span 5, but also presented itself as extra unwanted weight on these steel girders. The normal blasting techniques proved ineffective on removal of this thick coating and the contractor had to bring a large blasting machine capable of applying of up to 10,000 psi of pressure. This level of blasting proved very effective and the contractor was able to clean the girders to bare metal. All residue was collected through utilization of a good containment system. It should be noted that the City had previously tested this substance and had found out that it did not contain any hazardous material. The residue of this substance removal was stored in steel containers and the City coordinated their shipment to a local waste landfill.


Carbonaceous fire-proof coating on steel girders

Third, the bridge deck was designed with light weight concrete deck to achieve a lighter superstructure for better structural behavior from both vertical and lateral capacity standpoints. Although light weight concrete bridge decks have been used in many other parts of the country, its use in the State of Washington is limited and the performance of the contractor for this application was crucial. The special light weight aggregate (i.e., shale) was shipped from Utah. The aggregate had to be in a Saturated Surface Dry (SSD) condition to be used in the concrete mix and the mix's slump had to be within an accurate range to make this concrete pour a success. The City's construction inspection team, with the help of a material testing team in MTC, made this feat a reality. In fact, the completed deck did not exhibit any microcracks after installation; a condition that is very difficult to achieve with normal concrete deck applications, even with good curing treatment.

Fourth, following the deck removal, many hidden additional superstructure corrosions were exposed that had to be repaired. To address this potential field condition, the contract had a provision for force account corrosion damage repairs that the City/ Engineer was able to utilize. The City's construction management team was able to effectively utilize this bid item to address repair of all the discovered hidden steel corrosions.

6. **Additional conditions deemed of importance to the public works agency, such as exceptional efforts to maintain quality control and, if value engineering is used, construction innovations as evidenced by time and/or money-saving techniques developed and/or successfully utilized.**

Initially the design team performed an in-depth inspection of the bridge to accurately identify the locations and extent of the corrosion damage that was visible. During this inspection it was discovered that not only had the bridge settled by 8 inches at its south abutment location but also it had moved laterally toward the north by 4 inches due to recent significant earthquakes in the region. The lateral movement evidence of the bridge was recognizable through bearing and joint movements. Moreover, one of the fracture critical cap beams of the bridge had up to 100% corroded top flange and the bridge's cantilevered sidewalks also had significant damages. Due to the former damage, the City had closed one full travel lane on the bridge and due to latter damages, the City had closed down both sidewalks on the bridge.

The design team prepared construction documents and provided engineering services during construction on this major challenging steel bridge rehabilitation. The following are some of the unique and innovative aspects of this rehabilitation design:

- **Utilization of Light Weight Concrete –** To accommodate the City's desired bridge widening while keeping the overall loading stress demands to within allowable capacities of the structural elements of the bridge, a concrete bridge deck composed of light weight concrete was designed. Aside from the good attribute of minimizing additional vertical loading demands, the light weight concrete offered the benefit of keeping the additional lateral loading demands to an "insignificant" level, per Washington State Department of Transportation (WSDOT) guidelines.

View of bridge deck constructed with light weight concrete looking south

- **Seismic Resistance Enhancements –** Although the main objective of the project was to rehabilitate the bridge to its original design intents, many rehabilitations were made that enhanced the seismic behavior of the structure. Some of the more important rehabilitations with dual roles on lateral structural enhancements are summarized below:
    - All the frozen rocker bearings at both abutments were replaced with new neoprene pad bearings.
    - The bridge was jacked both vertically and horizontally back to its original geometry to release the internal stresses entrapped within the structure by the recent large seismic events.

Replacement of frozen bearings at the settled south abutment

  - Seismic catch blocks and longitudinal restrainers were provided for prevention of the superstructure collapse during earthquake events.
  - Additional column bracings were added to not only increase column vertical load capacities, by reducing their unsupported lengths, but also to incorporate the required additional lateral resistance capacity in the bridge.
  - Two column braces that had buckled during recent large earthquake events were replaced with new ones.

- **Widened Sidewalk through an Outrigger System –** The bridge's failing cantilevered concrete sidewalks were removed and were replaced with a widened sidewalk supported by a steel outrigger system. In order, to distribute the outrigger loading to all of the bridge girders, additional transverse cross-frames were added to the bridge's superstructure.

Close-up of bridge railing pillars

- **Aesthetic Bridge Railing –** To complement the architectural features of the Holy Rosary Church located on the south approach of the bridge, design team's architect, Makers Architecture, designed bridge railing pillars that resembled the cathedral features of the church building. Moreover, the crash-tested bridge railing in between the pillars was chosen to be an open classic looking concrete barrier.
- **Replacement of Exterior Girders –** Due to deterioration beyond effective repair and to provide additional strength required to resist the loading demands from the sidewalk outrigger system and the crash-tested bridge railing, both original exterior girders of the bridge were replaced with new girders.

Localized heavy corrosion subject to repair

- **Corrosion Repair and Paint –** All the identified corrosion damages of the bridge were repaired. Provisions were added in contract document that any corrosion that was not visible or discovered during the bridge's in-depth inspection could be covered through force account work by the contractor. Following the steel repairs, the whole bridge was painted per WSDOT standards for longevity and service life considerations.

7. Use of sustainable infrastructure rating system or the equivalent (such as the Envision rating system) to ensure project is sustainable.

The City of Tacoma uses the Washington State Bridge Inspection system to inspect, document, and evaluate all bridges in the City. This system provides a sufficiency rating for all bridges on a scale of 1 to 100 with 100 the value for a new bridge.

The Tacoma Avenue South Bridge had a sufficiency rating of 10.0 prior to the rehabilitation. Using this rating system, it was evident the bridge was in need of replacement or rehabilitation. We used this system in effort to determine the sustainably option of rehabilitating this bridge.

In an effort of sustainability, the City of Tacoma retained TranTech Engineering to perform an analysis of the bridge that would evaluate different options, including replacement or rehabilitation.

This study found the bridge could be rehabilitated for half the cost of replacing the bridge. The rehabilitation of the bridge is a sustainable action as it saves resources that would have been used to replace existing bridge elements that still have many years of serviceability remaining in them. Additional sustainability benefits include reduced impacts to the public as the time to replace the bridge would have been more than 50% more than the time to rehabilitate the bridge.

Through this rehabilitation the following sustainability measures were achieved:

Energy – Through rehabilitation of the existing bridge, less energy was consumed than demolishing the existing structure and building a new one.

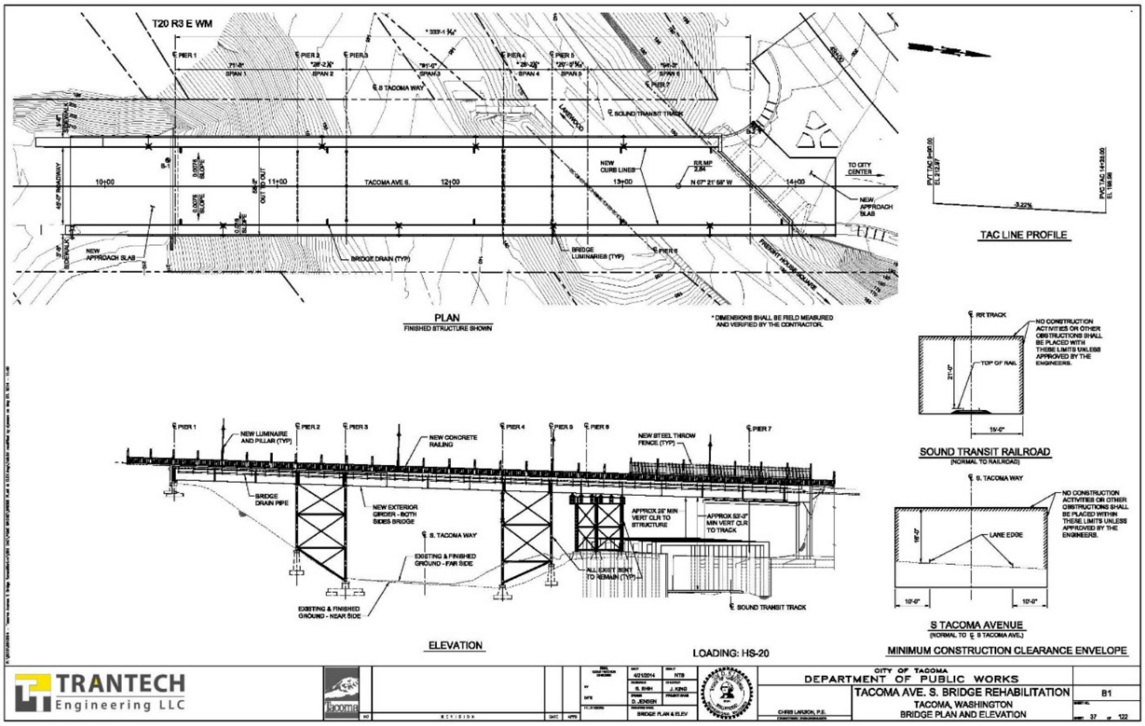
Waste – Less waste was generated

Water – Less water was consumed

Transportation – Less transportation was required

Landscape – Landscape and environment was preserved while historical values were restored and enhanced

On the following page, further details about the bridge structure are provided: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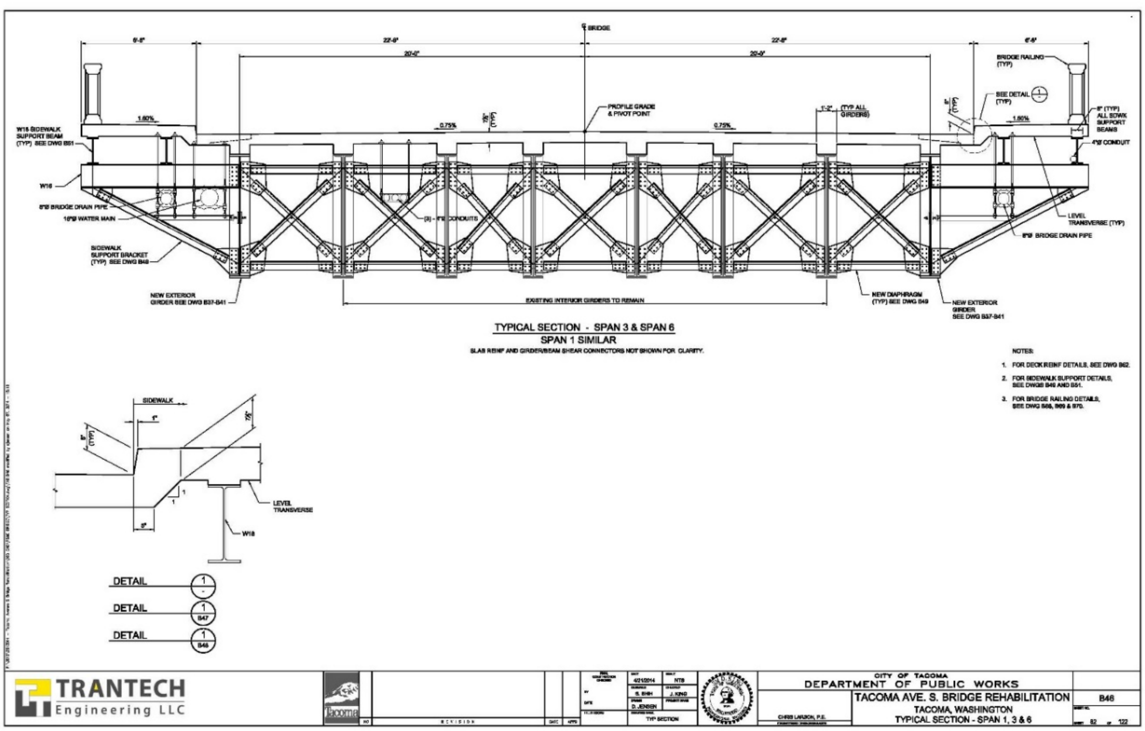
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