Bowman Road Bridges Replacement Project
County of Placer
Auburn, California

The Bowman Road Bridges Replacement Project involved the improvement of two existing bridges (see Figures 1 and 2) located on Bowman Road in Auburn, CA. Both are three-span cast-in-place concrete tee-beam bridges built in 1949 and are both 154-feet in length. At the time of project initiation both bridges were categorized as Structurally Deficient and Functionally Obsolete based on their inspected condition (See Figure 3).

Figure 1. South Bridge (19C-0061)

Figure 2. North Bridge (19C-0062)

Figure 3. Deck Deterioration before Project

Project Goals

The goals of the project were to determine the bridge rehabilitation or replacement solution that is most cost-effective while:

- Supporting modern trucks

- Eliminating seismic deficiencies
- Improving the bridge lane configuration for pedestrian and bicyclist safety
- Minimizing impacts to travelling public during construction
- Minimizing impacts to adjacent businesses during construction
- Developing solutions that do not impact UPRR rail operations during and after construction

Evaluation of the Bridge Improvement Options

Five options were developed and evaluated to determine whether to replace or rehabilitate the two existing structures. All options involved full closure of Bowman Road during construction as convenient detour options exist. Each of the options widened the deck to accommodate 2-12 ft lanes, a 5-ft sidewalk and 5-ft shoulder on one edge of the bridge, a 4-ft shoulder on the other edge of the bridge, and new bridge barriers.

- **Selected Option:** The option that satisfied the project goals with the least cost involved deck widening, deck rehabilitation with a polyester concrete overlay, seismic retrofit, and a corrosion protection system. It was also the most sustainable of the solutions as it required the least amount of demolition and reconstruction of any of the options. Over 90% of the existing structure was preserved.

Final design of this option was completed in November 2018. It satisfied the project goals through the following means:

- **Minimize impacts to travelling public** during construction: options for staged construction were evaluated and determined to not be feasible or cost effective. In lieu of staged construction, a detour was provided for vehicular traffic that resulted in only slight increase in travel time and distance. For pedestrian and cyclists, an on-demand shuttle service was planned to carry them around the construction zone (See Figure 4).
- **Minimize impacts to adjacent businesses** during construction: the detour resulted in reduced access to several adjacent businesses, churches, and schools. To mitigate the impact, public notifications (including email blasts, social media posts, and a project website) and special wayfinding measures were developed for implementation during construction to notify road users of the closure and how to access the businesses during it.

  Construction outreach website: https://bowmanbridges.com

  Bowman Charter School Traffic Detour Video: https://bowmanbridges.com/project-news/

  Video on how the project impacted area businesses: https://goldcountrymedia.com/news/173556/auburns-bowman-bridges-reopen-how-the-project-impacted-area-businesses/

- **Coordinate with utilities to maintain service** throughout construction. The critical utility relocation was a gas line on both bridges which could not remain during construction but was the only service communities north of the project. Through extensive coordination efforts a solution was devised where the County required construction work be timed around periods of low gas demands and the gas company provided temporary gas accommodation to the effected community. This coordination was successful and gas service to the community was uninterrupted throughout construction.
- **Develop solutions that do not impact UPRR rail operations**: significant coordination with UPRR was performed during the design phase to obtain approval for the temporary and permanent clearances

from the tracks. As a mitigation for the tight clearances, the project provided for installation of "guard-rails" on the tracks under the bridges.

Construction of the project was awarded in January 2019 with a low bid of $3.5M. Construction commenced in March 2019 and was completed in March 2020, see Figures 5 and 6 for the finished project and detailed discussion of the final details and construction work below.

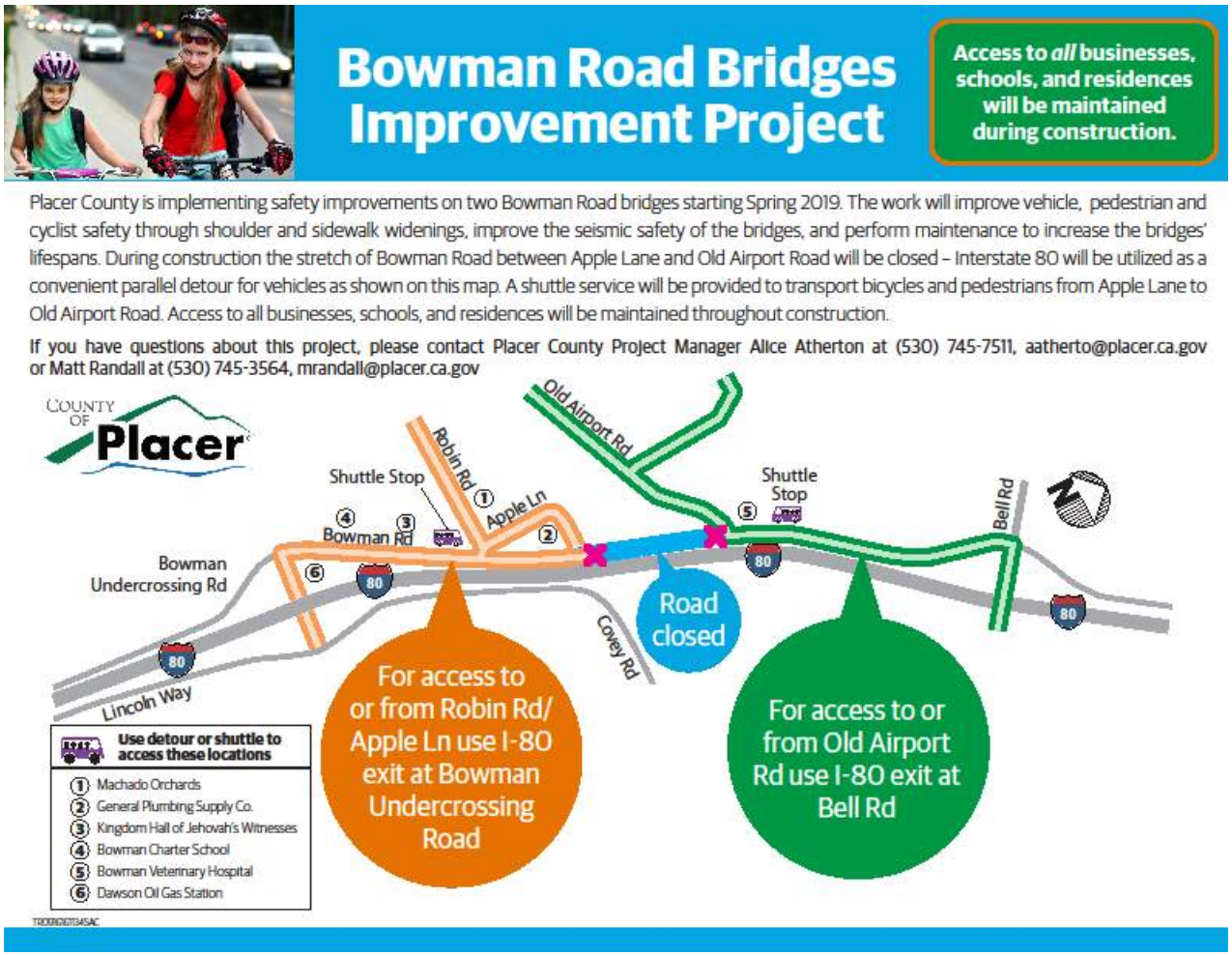

Figure 4. Community Outreach Flyer for Detour

Figure 5. Finished Project Overview

Figure 6. Finished North Bridge (looking north)

Detailed Discussion of the Improvements

Geometry Improvements/Bridge Widening

The original roadway alignment had sub-standard features at the south end of the south bridge, one of which was an angle point in the horizontal alignment, which limited the design speed. To provide the desired 45-mph design speed and accommodate the widening a horizontal curve was added to the south bridge approach. The addition of the horizontal curve necessitated widening the bridge with an additional girder to flare the bridge deck at this end (Figure 7). The additional girder required a column widening and abutment widening. The pile supported abutment was widened using micropiles (Figure 8). This novel solution was devised to accommodate construction with the tight space constraints, subsurface conditions, and presence of utilities under the abutment, while being cost-effective.

Figure 7. South Bridge Widening – Flared Deck at Added Girder

Figure 8. South Bridge Widening – Micropile Installation at Abutment Widening

Deck Replacement Staging and UPRR Protection

The partial deck and overhang replacement work required careful staging to prevent overstressing girders during construction. Part of the existing deck had to be removed so that the new overhangs could be constructed. This removal temporarily reduced the strength of the girders. Instead of shoring under the girders, which would have conflicted with the UPRR tracks, a staged construction scheme was designed that allowed the girders to be self-supporting but with tight controls in place on how much could be removed at a time. Additionally, protective covers were provided over the UPRR right-of-way throughout the overhang demolition and reconstruction which allowed more continuous operations improving work efficiency.

Figure 9. South Bridge Widening – Staged Deck and Overhang Replacement (beyond) and New Girder (foreground)

FRP Girder Strengthening

The widening of the bridge resulted in increased live load demands to the exterior girders. This was mitigated with strengthening using a Carbon Fiber Reinforced Polymer (CFRP) system. This system consisted of externally applied CFRP strips (Figure 10 & 11) applied to the girders to strengthen for shear and positive moment. The added strengthening allowed the bridges to maintain full HS-20 truck and California permit truck load capacity. The rarely used method of strengthening was highly effective and proved to be an efficient and cost-effective means of increasing girder strength.

The installation of the CFRP strips conflicted with an existing PGE gas line attached to the exterior girders. Extensive coordination with PGE was completed to ensure gas service was maintained to the community, even during periods when the line was removed from the bridge, as well as to coordinate the re-attachment of the PGE line which occurring midway through construction.

Figure 10. Girder Strengthening – Installation of CFRP Shear Stirrups with Anchors

Figure 11. Girder Strengthening – Installation of CFRP Shear Stirrups with Anchors

Bridge Deck Rehab

The existing deck had areas of delamination, spalling, and exposed corroding reinforcing. The work to correct this included spot repair of the spalled and delaminated areas (Figure 12), replacement of the overhangs (including barriers), and the application of a ¾" minimum thickness polyester concrete overlay (Figure 13).

Figure 12. Overhang and Partial Deck Replacement

Figure 13. Polyester Concrete Overlay Installation

Seismic

The seismic vulnerability assessment concluded that the main concerns in a seismic event were unseating of the girder rocker bearings (Figure 14) and strength deficiencies in the bent cap and columns. The bent cap beams were deficient for shear and positive moment strength, and the columns were deficient in shear strength.

A highly efficient retrofit strategy was developed that involved: (1) Catcher blocks installed between the existing bearing pedestals to mitigate the possibility of excessive seismic displacements unseating of the girders from the rocker bearings and (2) Infill walls between the columns to mitigate the strength deficiencies of the bent cap and columns (Figure 15).

Figure 14. Existing Rocker Bearings

Figure 15. Completed Infill Walls Installed Between Columns

Galvanic Protection

Due to the existence of chlorides in the deck and to mitigate the possibility of future corrosion due at the interface between new and old concrete, galvanic anodes (Figure 16) were placed throughout the replaced deck sections to provide additional corrosion protection and maximize the life of these rehabilitated bridges.

Figure 16. Galvanic Anode Placement

Project Team

Owner: County of Placer, Auburn, CA. **Project Manager:** Alice Atherton

Designer: Jacobs, Sacramento, CA. **Project Manager:** Chris Serroels

Construction Manager: HDR, Folsom, CA. **Construction Manager:** Greg Zeiss

Contractor: Bridgeway Construction, Vacaville, CA. **Project Manager:** Dan Baker