2021 Save California Streets Award Nomination

Efficient and Sustainable Bridge Maintenance, Construction and Reconstruction Projects

ITALIAN BAR ROAD BRIDGE REPLACEMENT PROJECT

COUNTY OF FRESNO

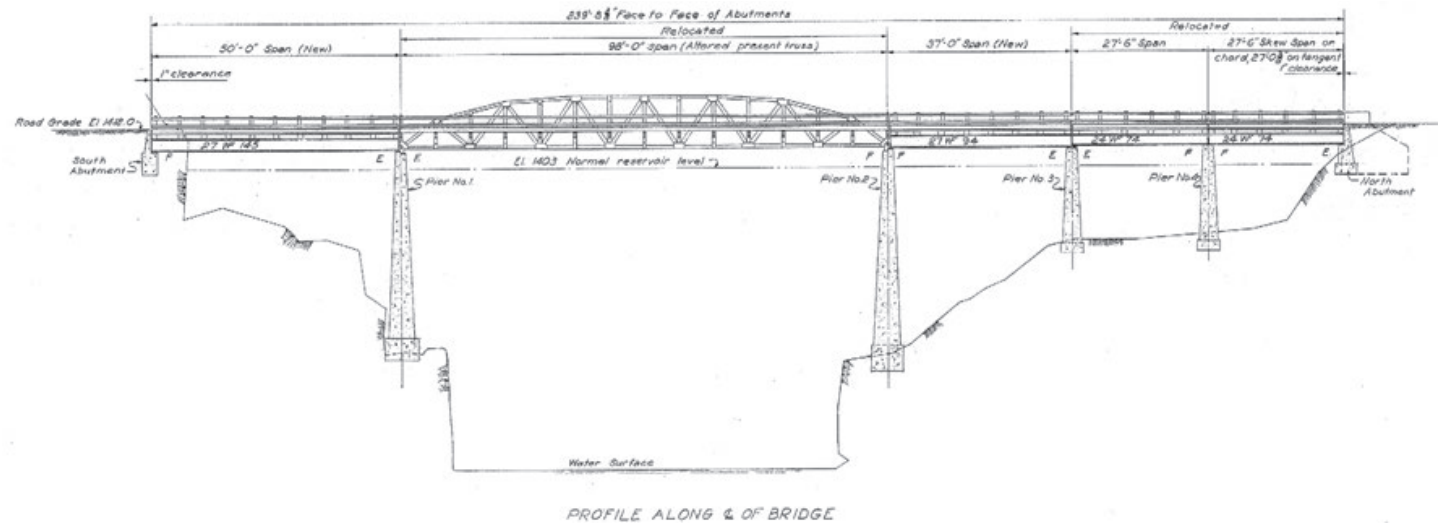
ITALIAN BAR ROAD BRIDGE REPLACEMENT

The historic San Joaquin River Bridge on scenic Italian Bar Road was constructed in 1927 as part of the Big Creek Hydroelectric System. The bridge, located in Fresno County, spans what historians have dubbed “The Hardest Working Water in the World” due to the intricate multi-dam system used for generating electricity. Redinger Lake is part of the Big Creek Hydroelectric project which includes a system of lakes, tunnels, steel penstocks and power houses that uses water to generate electricity.

The original bridge was a 98-foot-long, single-span steel Pratt pony through-truss with timber stringers and rolled steel floor beams crossing the natural course of the San Joaquin River. In 1950, the original bridge was raised onto new piers and the overall length was increased to 241 feet long by adding four additional approach spans. This was done to accommodate the rising water levels of Redinger Lake prior to the construction of Big Creek Dam Number 7, and has since served residents, recreationalists, and power plant employees.

In 2013, Fresno County determined the historic bridge had reached the end of its service life and could no longer safely support daily traffic. The County partnered with Quincy Engineering to replace the bridge. The team performed an extensive analysis of existing bridge deficiencies and conditions and worked closely together to evaluate cost-effective replacement bridge types and span configurations that would accommodate the site’s unique constraints.

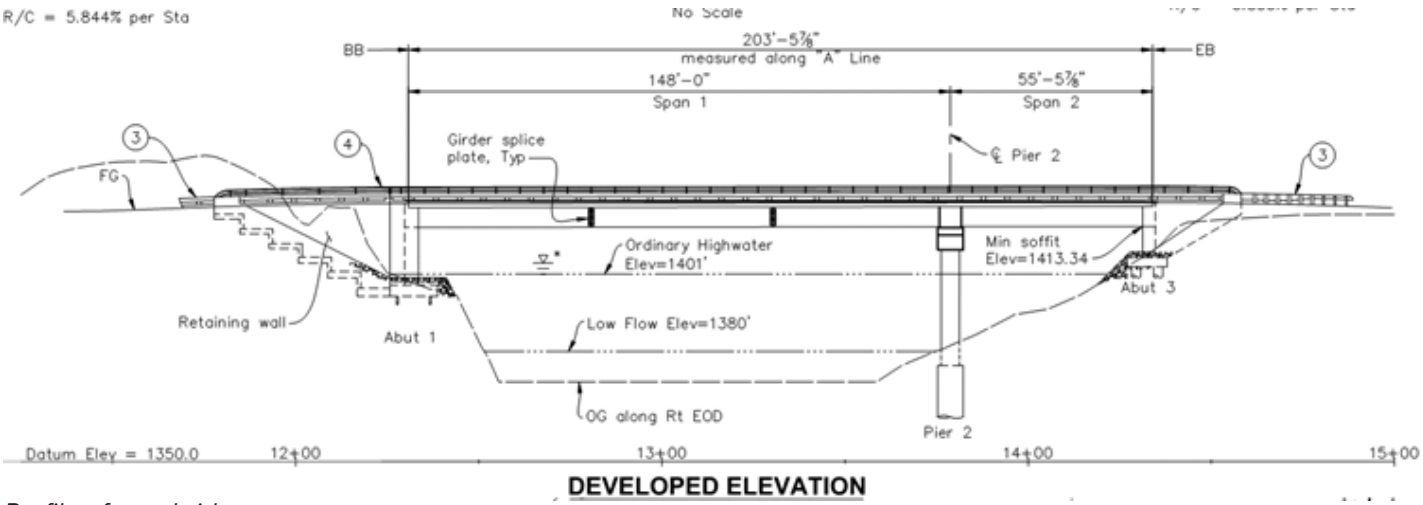
Top: Big Creek Dam No. 7 at Redinger Lake-photo courtesy of California State Water Board; Bottom: Original bridge had deteriorated after years of use and was no longer safe.



Profile of original bridge

The project design was more challenging due to the unique nature of the site. The bridge is located in a remote area on the border between Fresno and Madera Counties in a rocky ravine with narrow roads and tight curves. Several trucking routes and staging areas were evaluated to physically deliver material and equipment for construction and identify environmental issues beyond the bridge itself. This also resulted in the strengthening of another existing bridge en route to the site. The limited access controlled the bridge type selection and the impact to project funding had to be secured through the Highway Bridge Program. Fortunately, most of the affected land was managed by the U.S. Forest Service. They provided essential assistance throughout design and construction.

The County and Southern California Edison required that the existing bridge remain open during construction of the replacement bridge. The design challenge of keeping the road open required careful planning to strike a balance between the impacts to traffic during construction and the cost of realigning Italian Bar Road into the steep, solid granite banks.



Profile of new bridge

The final design provided an alignment downstream of the existing bridge minimizing the rock cuts and using staged retaining walls to keep the existing bridge in place for through traffic. Concrete stamping, staining, and manufactured stone veneer were added for aesthetic appeal that helped blend the new bridge with the landscape. Ultimately, Fresno and Madera Counties received a beautiful, long lasting, and low maintenance structure.

Traversing a Tough Site

For the average driver crossing the San Joaquin River on Italian Bar Road, the relatively small bridge might not seem terribly complicated in its design and construction, but as the engineering team can attest, designing a safe, cost-effective, and long-lasting crossing over the steep slopes of this remote section of the river was anything but easy. *The team developed innovative solutions to lessen the impacts to the environment and make construction more efficient.*

Temporary strengthening of a failing bridge on Italian Bar Road leading to the project site

Challenge: Crossing Troubled Bridges

One of the biggest hurdles presented by this project was delivering heavy construction equipment and materials to the site because of several smaller bridges along the way that were unable to support heavy loads.

Solution: Bolster the Bridges

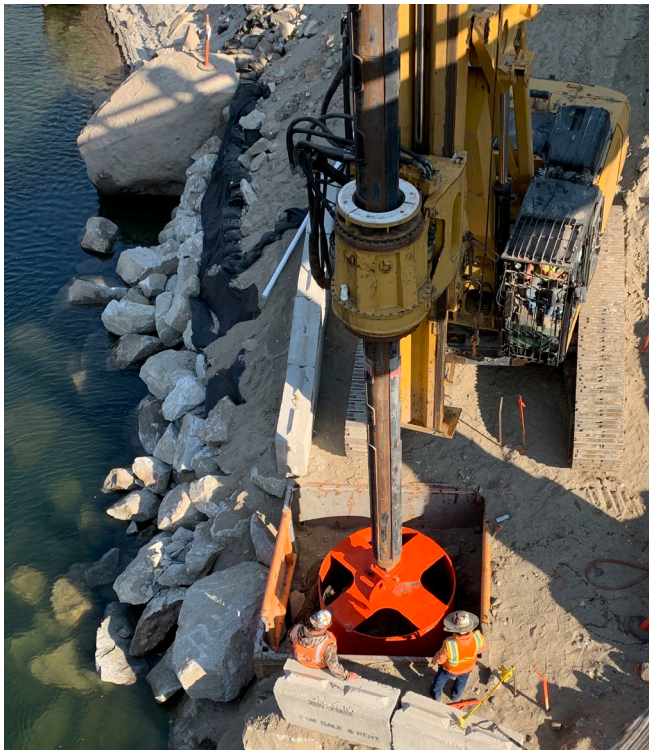
The Quincy team inspected the en route bridges, designing bridge reinforcements as needed, and acquired environmental clearance for one of the approach structures to ensure safe delivery of materials and equipment for the construction of the project. This also required knowledge and understanding of what equipment and materials would be necessary to construct the bridge and then verifying how and where it could be delivered to the project. Quincy reached out to several drillers and steel erection contractors during design to get a sense of the size and weight of the required construction equipment.

Challenge: Water is King

The hardest working water in the world doesn't stop for anything. Hydroelectric power demands and agricultural water needs in the spring meant that the bridge's foundation had to be constructed in the winter.

Solution: Designing Work Around the Water

Quincy's project manager coordinated with Southern California Edison (SCE) to develop a construction schedule that would work in conjunction with the low-water season. This is because the water level has to be maintained at certain levels to continue electricity production. Quincy's project engineer also planned the foundation locations to maximize structural efficiency while maintaining a constructible design. However, the water level had to be lowered to the lowest level possible so the new bridge supports could be constructed and the older bridge supports could be removed. This required coordinating construction needs with water resource needs which are based upon



Pier 2, Cast-in-Drilled-Hole Rock Socket Foundation Installation during Low-Water Season in Dec. 2019

complex water and power delivery analyses. Further coordination and planning had to be done because timing of the lower water elevations (October-January) had seasonal rain flows and runoff.

Because the upper inlet to the reservoir at Mammoth Pool is uncontrolled, the Contractor and CM Team had to be looking at forecasted weather as well as agricultural water delivery needs. Fissures in the subsurface rock created issues with drilling and setting concrete in the pier pile which was exacerbated by the rising and falling reservoir water levels.

Looking at Pier 2 from Abutment 1 in January 2020

Challenge: A Tight Site
Obstacles presented by the small site included limited access for large cranes, and lack of adequate space for staging heavy equipment and materials.


Rock slope protection at Abutment 3 using excavated granite helped reduce off-haul cost

Solution: Design to Fit and Maximize Existing Materials
After carefully considering the limitations for delivery and staging of material and construction equipment, the team designed a bridge that could be constructed using smaller pieces, requiring only lightweight equipment loads, and that could successfully be assembled on a constrained site. The contractor did a great job of staying on schedule despite the difficulties they were presented with. Large cranes had to be disassembled and reassembled to cross some of the old bridges getting to the site.

In addition, locations were carefully chosen to minimize the bridge footprint and maximize the use of the exposed and shallow depth bedrock. The Quincy team incorporated remnants from the rock blasting and excavations into project improvements, such as structural backfill and rock-slope protection, to reduce the off-haul cost of excavated granite.

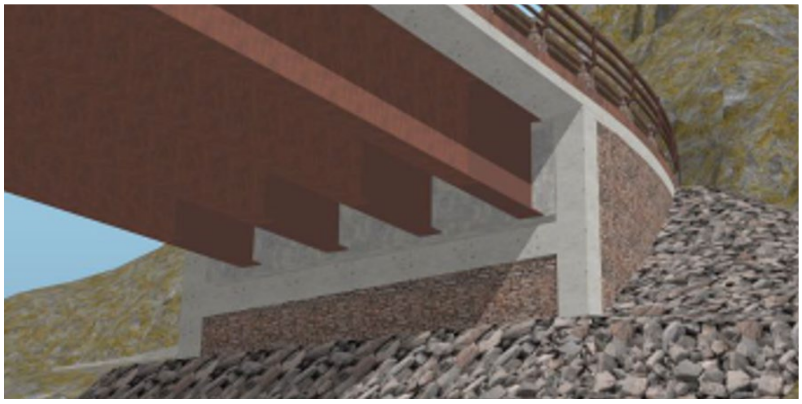
Designing a Stand-out Bridge That Still Blends In

After selection of a two-span structure steel girder bridge, the project team stepped up to the challenge of engineering an affordable yet innovative structure that would integrate seamlessly into the landscape's rocky outcroppings and oak woodlands while respecting the lake's hydraulic and recreational demands.

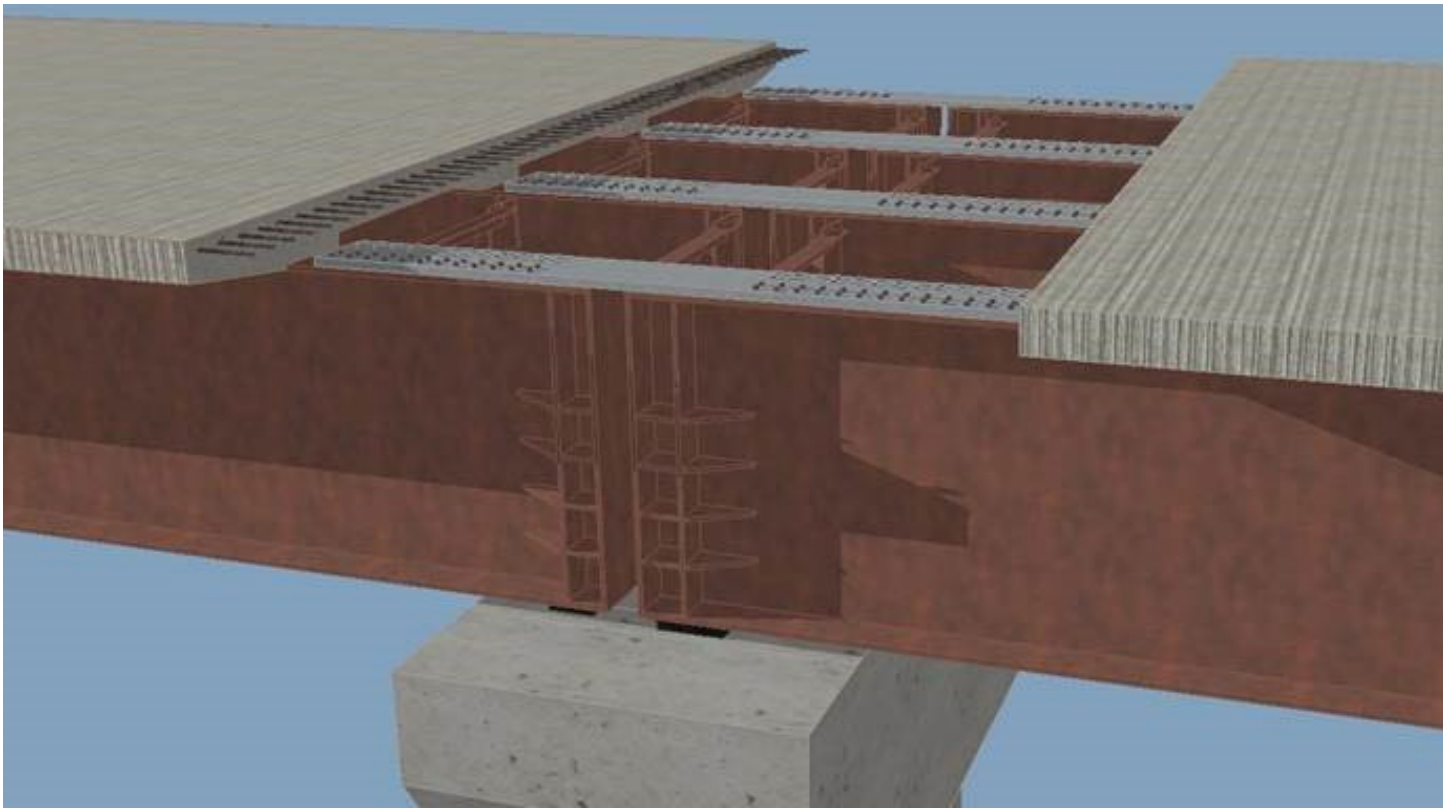
An Innovative and Sustainable Bridge
Quincy incorporated cutting-edge steel design techniques to increase overall durability and reduce future maintenance costs of the bridge. Steel, in general, is more sustainable than concrete and is the most recycled material. Thus, the steel ore utilized to manufacture and fabricate the steel girders has a high percentage of recycled material in it. In addition, instead of paint coating, weathering steel was selected to minimize the County's future maintenance efforts. Weathering steel does not require paint coating and instead develops a sacrificial layer, often called a "patina". This means that the steel

is fabricated, erected, and then remains maintenance free.

In addition, 3-D models of the bridge aesthetics were provided to the County to inform decisions on the project layout and bridge aesthetics. The design team worked closely with the National Steel Bridge Alliance on the latest steel design and detailing practices involved with creating a jointless steel bridge using “Simple Dead Load, Continuous Live Load” analysis approach—a technique with an added bonus of balancing the structure’s weight.



Top: 3D Model of bridge aesthetics; Bottom: 3D Model of Simple Dead Load, Continuous Live Load analysis



This technique allowed for the simplicity of initially erecting two sets of single span girders while ultimately achieving the added strength of continuous girders over the intermediate support. A special deck pour sequence was specified to allow the dead load weight of the concrete deck to be applied to each span as a simple beam. Continuity plates were used to stitch the girders from each span together over the pier, creating additional strength and redundancy for vehicular live load. A reinforced concrete diaphragm was poured around the girder ends over the pier cap to lock in the rigid connection and protect the girder ends from corrosion. The final concrete deck pour provided the last bit of required tensile strength by utilizing deck reinforcement placed using mechanical couplers. Quincy designed the bridge for each step of construction ensuring that loading met AASHTO Bridge Design Specifications requirements, including wind loads. Quincy utilized 3D renderings to eliminate potential conflicts during erection and to ensure that each step was practical for construction.

Mitigating Environmental Impacts

The existing steel bridge was in a significant state of disrepair. There was flaking lead paint which was dropping off portions of the steel truss. There was a timber deck with steel plates that resulted

in materials and detritus dropping through the deck into the reservoir. This was especially common during rain events when the runoff would simply drop through the deck into the reservoir with potential contaminants from the deck surface. The new deck was designed to capture all debris and runoff, which will be carried off the bridge instead of dropping through. As noted above, the new steel girders are made with an uncoated weathering steel and will not have coating falling and dropping into the water.

The design team also worked very closely with various crane companies during the planning phase to understand the loads, limitations and controlling factors for delivering material to the site and constructing in place. This involved understanding sizes, load and equipment variables and how they related to size and footprint necessary to complete operations. This was critical because this controlled determinations for impact areas, traffic staging, clearing and rock removal which were key components in clearing the environmental process.

Despite all the challenges this project presented, including the construction site having to be evacuated in September 2020 due to the devastating Creek Fire, the new Italian Bar Road Bridge was successfully constructed and will provide a safe, sustainable and low maintenance crossing over Redinger Lake for years to come. Final closeout of the project is expected in March 2021.

PROJECT TEAM

Lead Agency: County of Fresno

Partner Agencies: Madera County, U.S. Forest Service, Southern California Edison

Designer: Quincy Engineering

Environmental: Area West

Geotechnical: Kleinfelder

Hydraulics & Hydrology: WRECO

Contractor: American Paving

Steel Fabricator: Stinger

Steel Erection: Adams and Smith

Construction Management: County of Fresno with support from Quincy Engineering