A DELICATE TOUCH

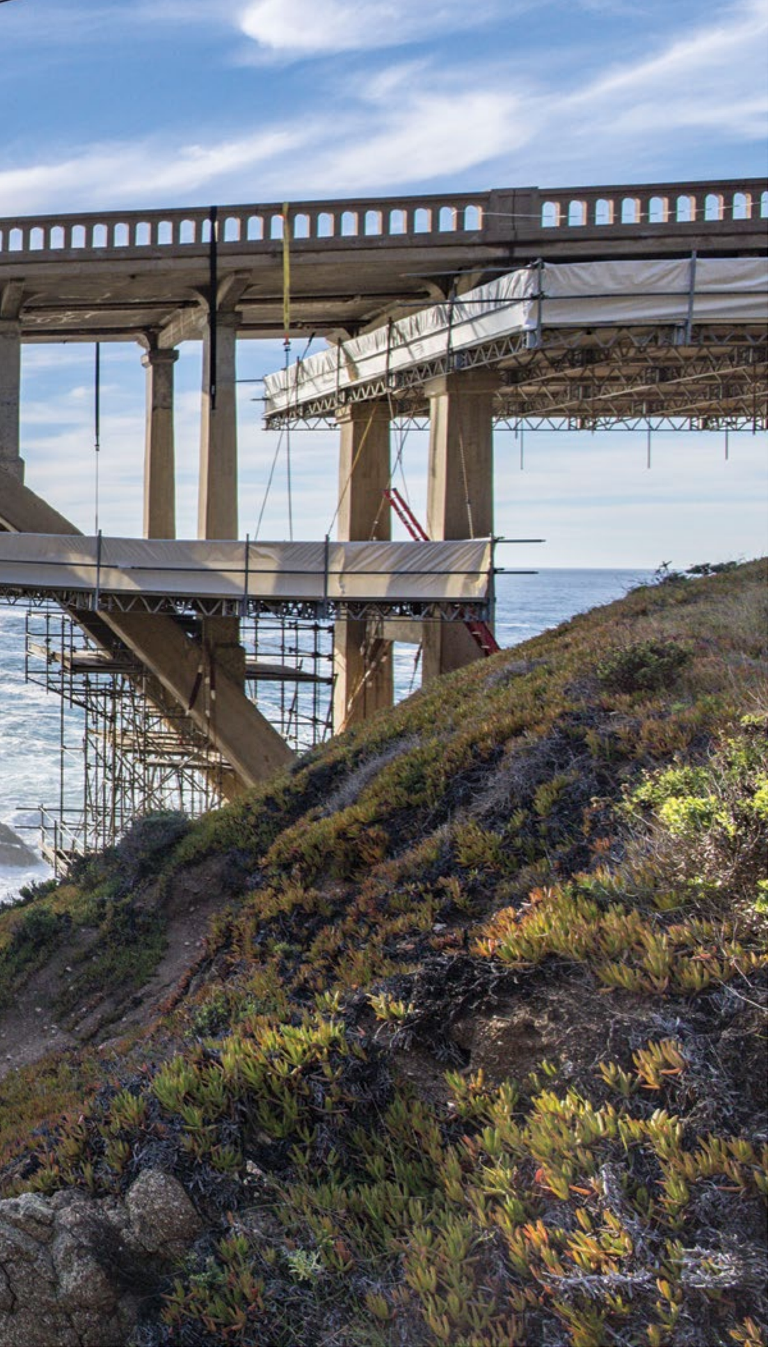
How the historic Granite Canyon Bridge maintenance project came together

By Shannon O'Connell, Contributing Author

WHEN REPAIRING CONCRETE arch bridges, it pays to remember that if plan A doesn't work, the alphabet has 25 more letters. Even bridges that should be similar have unique structural designs, different capacities, "as-built" variations from original plans, and, most critically, disparate stages of damage or decay. Case in point: The Rocky Creek and Granite Canyon Bridges.

With a total length of 288 feet, an arch span of 127 feet and a deck width of 24 feet, the Granite Canyon Bridge features an abutment and two bents on each side and 10 spandrel columns encompassing the arch. Although very similar to the Rocky Creek Bridge, which is located just 4.3 miles to the north, the Granite Canyon has a smaller span. This is why, when the California Department of Transportation (Caltrans) contracted with American Civil Constructors (ACC), a leading full-service civil contractor, and BrandSafway, an access and industrial service company, to repair the concrete of the Granite Canyon Bridge in 2021, the team initially believed it could combine the two previous suspended access techniques used on Rocky Creek.

In 2019, Caltrans, ACC, and BrandSafway successfully collaborated on the repair of Rocky Creek Bridge, an open-spandrel concrete arch bridge. For deck resurfacing and repair of the concrete railings, the road surface was used to support the structural load of a rigid suspended platform erected in modular segments (as the platform deck uses marine-grade plywood supported by a truss system, the segments typically measure 8-by-8 feet or 8-by-4 feet). On that project, ACC core drilled 2.75-inch-diameter holes through the foot-thick concrete deck, dropped suspension chains through and connected them with pad eyes welded to the underside of a structural steel plate, which fit relatively flush with the road surface. Several years earlier, in 2012, when repairs were needed on the same bridge, several tiers of platform were suspended from chain looped over the arches.



However, when Caltrans, ACC and BrandSafway learned core drilling in the center section of the Granite Canyon Bridge's span would jeopardize the concrete slab's structural integrity, Plan A had to become Plan B. Later, Plan B had to be changed upon discovering excessive decay at one of the spandrel columns, and that further evolved when two spandrels required a splice zone (overlapping sections of new rebar/concrete), which reduced the structural load.

The final iteration of the engineering plans for Granite Canyon took in the following considerations:

- No access platforms could be suspended beneath the main arch of the bridge until repair of the arch ribs was complete.
- All unsound concrete in each arch rib reinforcement splice zone would be repaired prior to making any other repairs, and only one splice zone at a time could be repaired.
- Ribs would be repaired one side at a time with road deck closed above the ribs/spandrel columns/girders being repaired.
- The weight was 2,000 pounds thanks to a very specific access erection and repair sequence (the suspended access system was not included in this), but this total only lasted until the arch rib repair was complete.
- Only upon completion of unsound concrete repair on the arch ribs could work proceed with repair of the spandrel columns and girders.
- Locating all suspension chains within 1 foot of a spandrel column face to ensure adequate load support.
- Chain location must allow access for the use of an electrochemical chloride extraction (ECE) process from the steel to mitigate corrosion (see sidebar) and repair the concrete surface.

Thanks to continuous communication between ACC, BrandSafway and the Caltrans engineering and project management teams, a final plan was agreed upon that would accommodate the repair process and bridge load limitations (and do so while maintaining the schedule and staying within budget). The ultimate solution required a unique, multi-tiered configuration of suspended scaffold, supported scaffold, shoring and rolling scaffold.

CAREFUL SEQUENCE

The access processes started with core drilling about 40 holes on the north and south sides of the bridge for suspension chains. Here, a 40-by-32-foot section of suspended platform would extend from the bridge abutment to two bents at the base of the main arch. Workers could easily reach this approach span from stairs at either end of the bridge, as well as access the underside of the road for repairs.

To access the center span (spandrels four through seven) with a 36-by-32-foot platform, suspension chain was looped over the arches next to the spandrel column face. The chain was sheathed inside old firehose so its rubber liner and woven cover could protect the concrete. A starter section of the platform was erected on the road deck and flown into place with a crane. The suspended scaffold system used a node/pin/pivoting truss system, which enabled erecting subsequent sections in the air.

Because no loads could be suspended from the splice zones at spandrels three and eight, access for spandrels one through three and eight through 10 required one of the more unique plans devised. To start, a 16-by-32-foot section of platform was suspended at the base of the arch with chains looped over arch ribs at spandrels two and nine and on the horizontal cross members of spandrels one and 10. Next, the access crew erected five levels of ground-based or supported scaffold, which would not just provide access to the arch and spandrels one and 10 but would also serve as shoring to partially support the 28-by-32-foot suspended platform above it.

The final challenge occurred after erection of the supported scaffold but before it was used as shoring. Concerned about total weight when personnel and materials were added,

CORROSION EXTRACTION

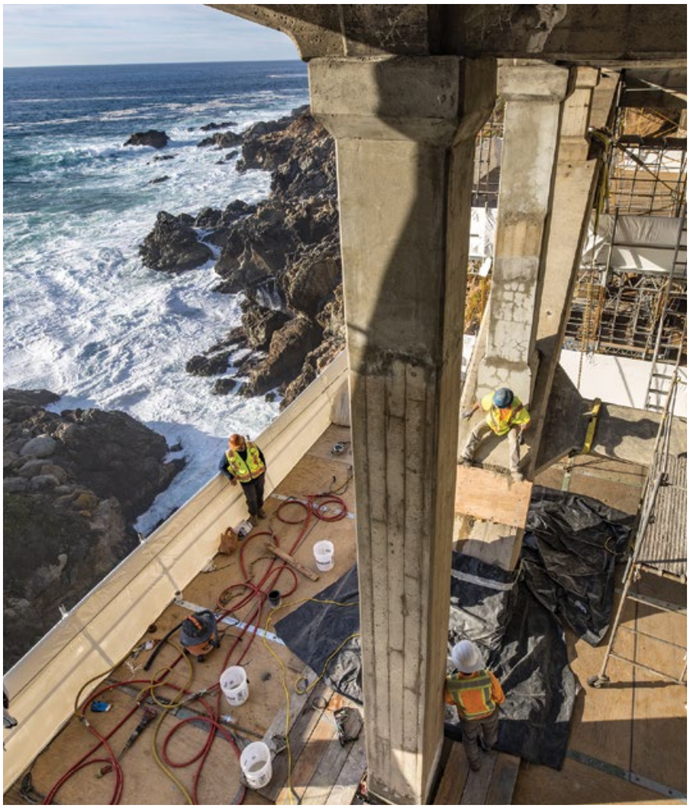
Corrosive marine environments promote rapid spalling of the concrete. Caltrans identified numerous areas of the Granite Canyon bridge where the concrete needed to be filled and/or patched. ACC would also need to install permanent zinc anodes, seal the concrete to protect the bridge from further corrosion, and blast and paint all steel surfaces.

Except for the bridge girders and prestressing beam, Caltrans' specified treating all concrete surfaces with electrochemical chloride extraction (ECE). ECE extends the life of concrete structures by returning them closer to an as-built condition, an important factor for the historic bridges along SR 1, many of which were built during the New Deal construction era.

ECE basically turns the bridge into a giant electric grid with power supplied by diesel generators. To start, ACC drilled small holes in the concrete so the rebar could be connected to the negative side of the power supply. The positive terminal was connected to a temporary anode consisting of mesh nets and ribbons on the surface of the concrete. The nets are encased in a conductive media made from potable water and calcium hydroxide. The media has a pasty consistency so it can be applied with a shotcrete gun and then wrapped in plastic to minimize evaporation.

The electrical current repels the negatively charged chloride ions away from the rebar and draws them to the positively charged anode, where they are absorbed into the highly alkaline conductive media. ECE removes most of the chloride from around the steel and, because it generates a lot of hydroxide ions, it increases alkalinity around the rebar to obtain a high level of repassivation of the steel. The process, which takes six to eight weeks, also removes 50 to 90% of the chloride from the concrete, further mitigating the effects of chloride-induced corrosion.

Workers safely access the underside of Granite Canyon Bridge to inspect one of the spandrels, a triangular space between the bridge's arch and rectangular frame.



Workers could easily access the underside of the bridge. Photos are courtesy of Robert Barbutti.

Caltrans requested changes to some of the lower platform suspension locations. To accomplish this, grip hoists were used to lift the lower platform/scaffold combination just enough to remove tension from chains. This would allow connecting new chains that had been prepositioned in the correct location.

At this point, and after all the concrete repairs had been made, ACC was able to place rolling scaffold on any of the suspended scaffold, making it easy to access all the concrete surfaces.

ON TIME AND ON BUDGET

Despite all the new challenges encountered, the repair work on the Granite Canyon Bridge was completed without any lost time incidents and within the allocated budget for equipment and materials and within the allocated November 2021 to June 2022 schedule.

BrandSafway Project Manager Greg Mallek says that compared to steel bridges, "Every concrete arch bridge presents a unique challenge. The very structure from which you're suspending may be damaged or deteriorating. It's part of what makes our work so interesting. We love a good challenge, especially when collaborating with ACC and Caltrans to preserve these historic bridges." R&B

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