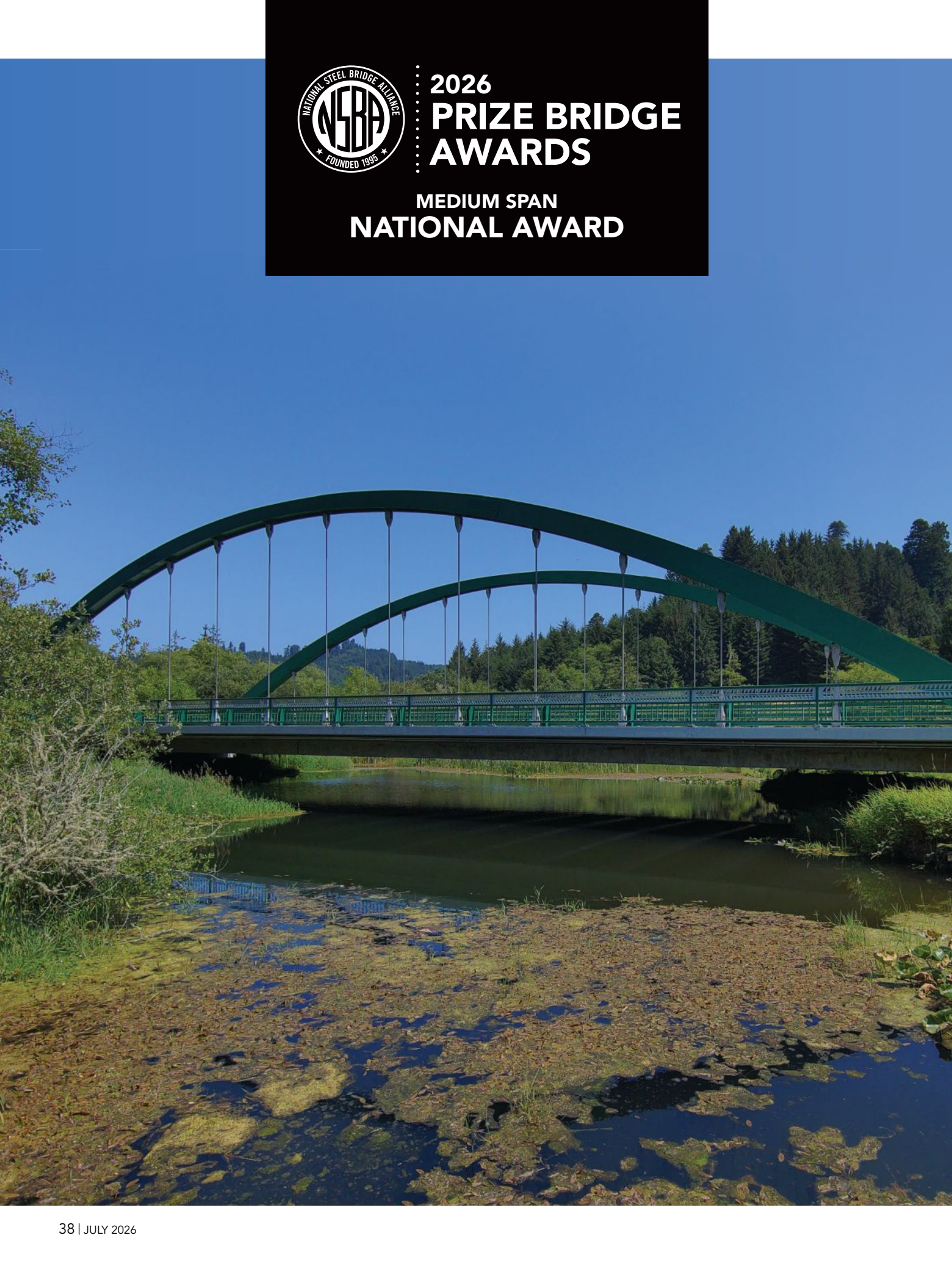




2026  
**PRIZE BRIDGE  
AWARDS**

MEDIUM SPAN  
**NATIONAL AWARD**





All photos courtesy of Caltrans

## PANTHER CREEK BRIDGE

### Klamath, Calif.

**A TIED ARCH BRIDGE** in Northern California is one example of a steel structure achieving primary project requirements that sometimes don't mesh: the bridge's aesthetic matches its surrounding greenery, while its design meets stringent environmental requirements by keeping substructure units out of the water. It's also the first California Department of Transportation (Caltrans) project to incorporate tsunami planning into its design.

The environmental considerations for the coastal town of Klamath, Calif., were the primary driver for the steel tied arch design choice. The bridge crosses Panther Creek and is adjacent to Panther Pond, both sensitive wildlife habitats that support coho salmon and other rare aquatic resources year-round. It is located on the Yurok Reservation, where fisheries are a cultural staple. Caltrans developed the design in consultation with the Yurok Tribe.

The bridge needed to span 162½ ft in one clear span, because putting piers in the water was deemed environmentally disruptive. The steel arch ribs facilitated a structure depth of 3 ft, 1 in. below the surface that avoided roadway embankment impacts and roadway grade raises, plus maximized the hydraulic clearance.

The project's setting drove additional structural features. Overhead transverse bracing was eliminated to provide unimpaired vertical clearance for the route's loosely controlled logging trucks. All structural steel, including the hangers, ribs, and floor beams, was galvanized for corrosion protection and painted green to match the wooded surroundings. The coatings ensure a 100-year service life in a coastal environment. Elsewhere, combining steel with concrete tie-beams and post-tensioning created sufficient stiffness and resilience. The seismic and tsunami design required ductile anchorage at the knuckles, which was more easily done with steel.

Other materials were considered but not chosen. All-concrete solutions were dismissed because of limited clearance over water and constructability in soft soils with liquefaction concerns.

### Coastal Considerations

The Panther Creek bridge was the first Caltrans-designed project to employ probabilistic tsunami hazard analysis and runoff mapping when planning began in 2017. Tsunami hazard and design parameters were documented in a tsunami hydraulic report with wave elevation, scour and velocity, which was the first of its kind at Caltrans.

Panther Creek is located behind coastal bluffs about 1 mile from the Pacific Ocean and is a low-lying tributary of the Klamath River. The tsunami elevation is estimated to be 7½ ft above the bridge deck, inundating the structure. Because the initial estimate of wave velocity was 10.6 ft per second, the project team pursued design concepts to resist hydraulic forces and debris forces and to provide anti-buoyant venting. But after two years of developing an understanding of the ASCE hazard tool ([www.ascehazardtool.com](http://www.ascehazardtool.com)), the velocity estimate was reduced to zero—like a bathtub slowly filling over the bridge.

In the end, while the bridge is not a striking example of tsunami design—the vents and the rib hardening are its only features—the project played a pioneering role in developing Caltrans' practical application of probabilistic tsunami design tools and practice.

Panther Creek was Caltrans' first tied arch design in decades, and designing one in 2017 meant adapting its modern seismic criteria to a design that's seismically classified as a nonstandard structure type. The design team leaned on its experience retrofitting through-trusses, which highlighted the vulnerabilities of connections, non-compact members, and potential plastic hinge locations in portal frames. Project-specific design criteria (PSDC) were developed for the new through arch to ensure connection performance, ductility, controlled locations of damage, capacity protection, and resilience.

The arch ribs have no bracing and instead cantilever from transverse, precast concrete end beams that are integral with the bridge deck. The rib to end beam to rib subsystem acts like an inverted moment frame. The rib anchorage was designed as a ductile earthquake-resisting element to capacity-protect the rib and the end beam, which is analogous to a bent cap. It's a cost-effective method of post-earthquake assessment and repair. Partial grout fills stiffened the steel rib ends against impact from vehicles and tsunami debris, another cost-effective measure.

The bridge's earthquake resisting system (ERS) is defined as elastic-with-ductility, where the main components remain elastic, but the rib anchorage may yield. This ERS helped the bridge satisfy its performance criteria as a recovery bridge in Caltrans' classification system, a category that requires prompt restoration of service. The PSDC anticipated the recovery category two years before it was codified in Caltrans' *Seismic Design Criteria* 2.0 in 2019. The recovery bridge category was adopted because the project is located within the area's tsunami inundation zone and the local agency's tsunami evacuation zone.

The Panther Creek bridge's anchorage consists of 1-in.-diameter Grade 36 rods anchored with a free length of 30 in. While strength, capacity protection, and ductility of elastic anchorages were well established, the design applied new observations and conclusions from ductile-anchorage research performed at UC San Diego. Notably, the UCSD research investigated the potential of removing and replacing yielded, threaded components. To promote resiliency, the PSDC adopted UCSD's recommended 4% anchor rod strain limit.

## Getting it Built

The design chose Grade 50 plate thicknesses so that the rib is a compact section. With those thick plates, the design did not require internal diaphragms, even at the hanger locations. Fabricator Thompson Metal Fab added diaphragms spaced at about 6 ft to control welding distortion. The cross-section was constructed with fillet welds after consultation with the National Steel Bridge Alliance (NSBA). The fillet welds are economical, but their asymmetry can contribute to distortion. Welding was done by hand.

The fillet welds can also contribute to stress concentrations. These transverse stress concentrations are not significant for a member loaded longitudinally and vertically. The rib cross-section is reliable in longitudinal compression, which renders most concentrations a non-issue. The

## Bridge Stats

Crosses: Panther Creek  
Span length: 162½ ft  
Total length: 168 ft  
Average width: 56 ft  
Steel weight per deck area: 28 lb/sq. ft  
Steel tonnage: 133 tons  
Approximate cost: \$5.6 million



plans called for only one CJP weld, located at the rib-to-baseplate connection.

After galvanizing, the ribs and floor beams traveled back 215 miles from the galvanizer to Thompson Metal Fab for painting. The paint completed a duplex coating system of hot-dip galvanizing covered by a two-coat paint system (zinc-rich undercoat and two finish coats of acrylic color). Hot-dip galvanizing has been used at a handful of bridges in the Midwest, and the Panther Creek bridge marked its first Caltrans use. Galvanizing for long life was the difference-maker in securing maintenance support for a steel bridge on the north coast.

Although the arch rib is in compression, the rib plates are not butted against each other by design. A butted connection requires precise machining. Instead, the rib plates are separated by a 3/8-in. gap at CL splice. Rib compression is carried through the bolts and splice plates. Erecting and splicing the arch ribs took seven days.

Caltrans' design team developed a detailed construction sequence to build a tied arch without touching the water below. The team chose Accelerated Bridge Construction, known for ability to minimize jobsite impact, and detoured traffic to a temporary bridge as the project's first step. Precast concrete abutments were then assembled with cast-in-drilled-hole pocket connections. The steel arch ribs were erected as free-standing elements before the floor beams and deck were constructed.

Due to the loose gravel in the substrate of nearby Hunter Creek, a significant amount of additional pile had to be driven to achieve bearing capacity for the bridge. Material delivery and traffic control coordination between contracts needed to occur due to the unforeseen slides at last chance grade during construction.

The bridge, which carries California Highway 101 opened in March 2024 and replaced a 1950s structure that had reached the end of its service life.

#### Owner

Caltrans, Sacramento, Calif.

#### Structural Engineer

Caltrans, Sacramento, Calif.

#### Steel Team

##### Fabricator and Detailer

Thompson Metal Fab, Vancouver, Wash. 

##### General Contractor and Erector

Golden State Bridge Engineers & Contractors, Benicia, Calif. 



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