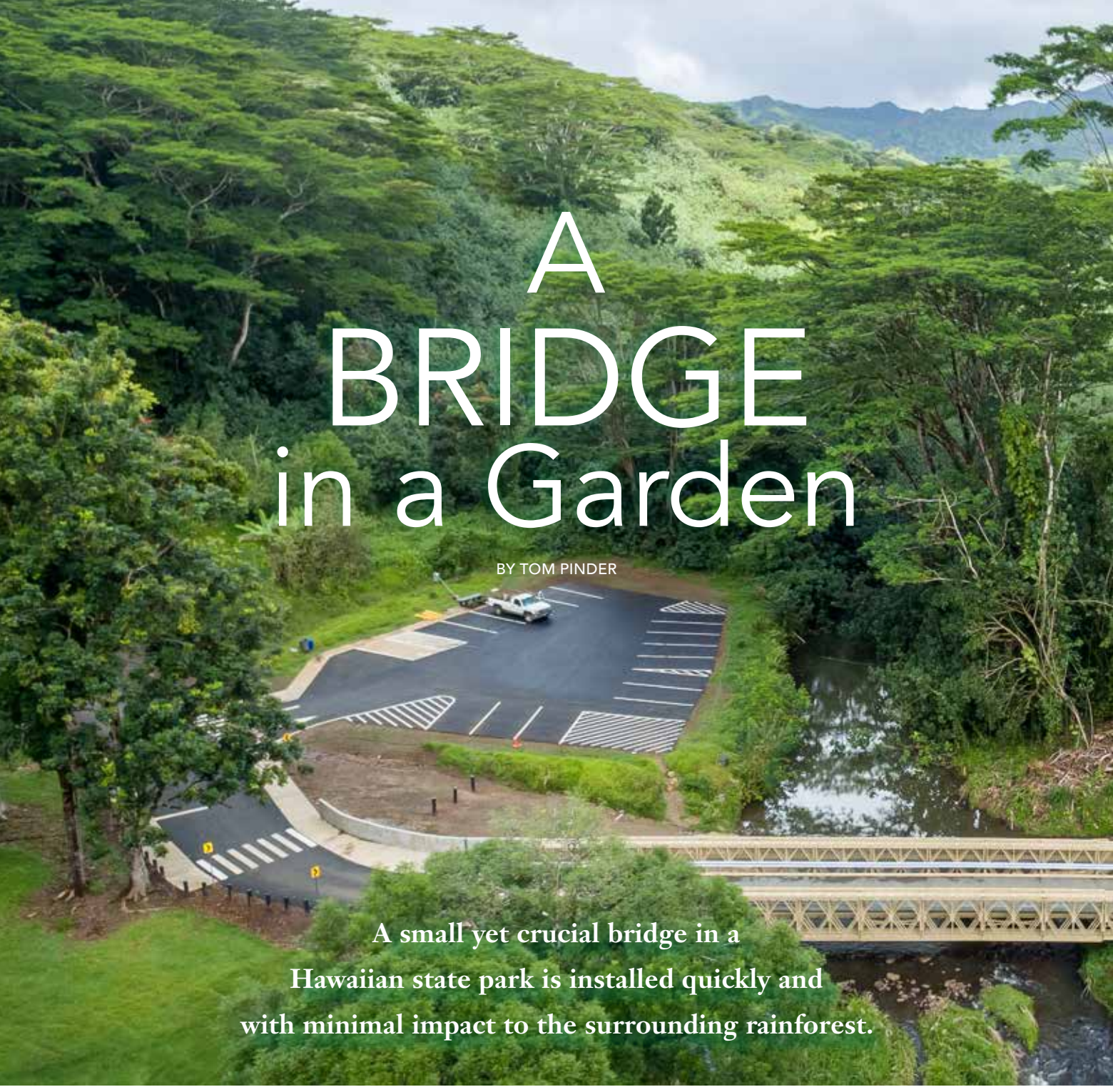
# A BRIDGE in a Garden

BY TOM PINDER



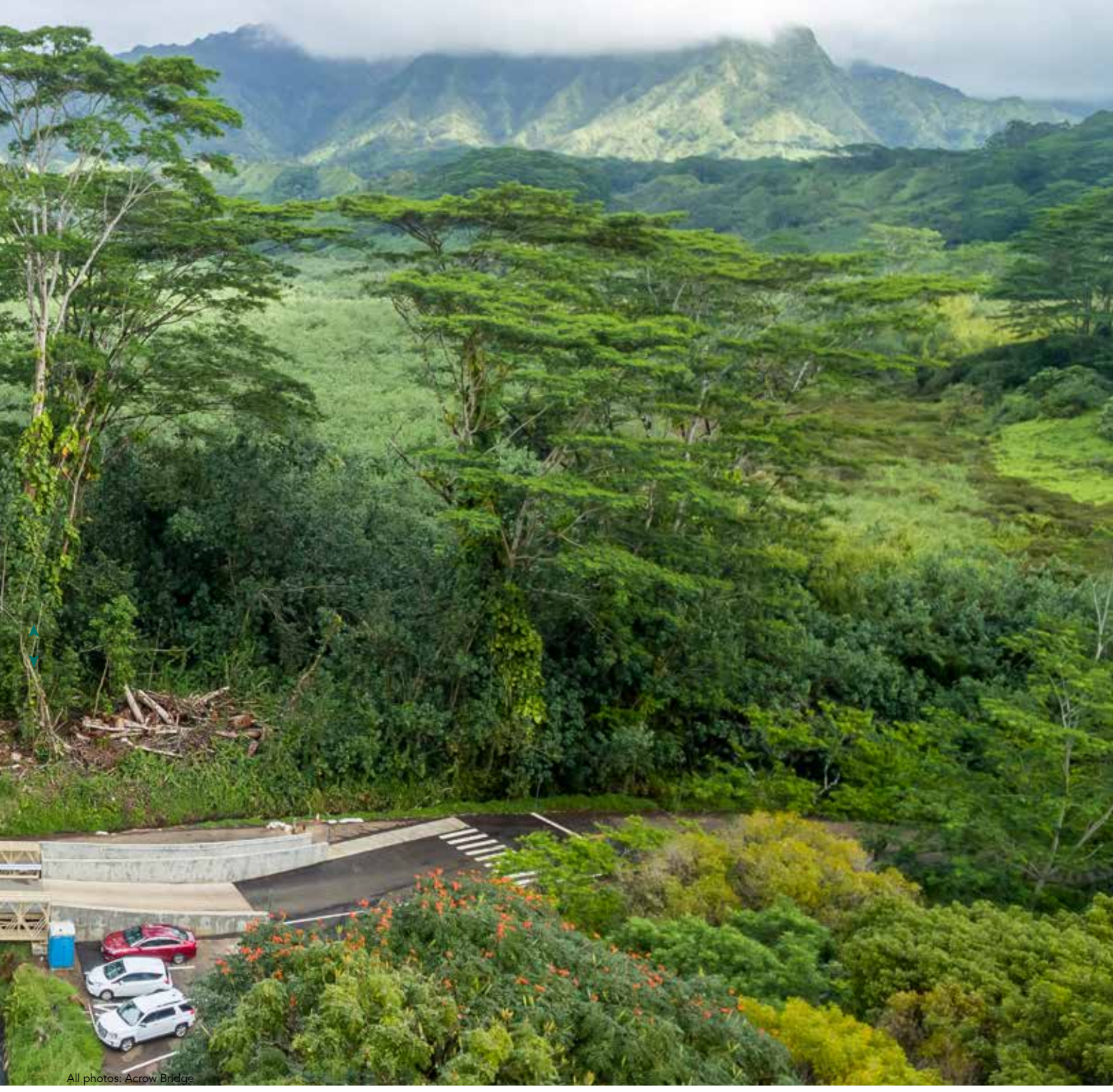
**A small yet crucial bridge in a Hawaiian state park is installed quickly and with minimal impact to the surrounding rainforest.**

**Tom Pinder** is Acrow's western regional sales manager.

**THE HAWAIIAN ISLAND OF KAUAI** is nicknamed "the Garden Isle" thanks to the tropical rainforest covering much of its surface.

A recent bridge preplacement project deep in the heart of this lush landscape was built with the goal of maintaining that green status and addressing the ecological and land management concerns of state regulators and community groups, not to mention the thousands of people who use the area every year. The project's location, the Keahua Arboretum in the Keahua State Forest, is home to native plants and vegetation introduced by the University of Hawaii and is enjoyed by locals and tourists for picnicking, swimming, hiking, biking and horseback riding.

The original route in and out of the preserve, which crossed the Keahua Stream, was a concrete roadway that had sunk into the stream over time and often flooded after heavy downpours, rendering safe passage difficult if not



All photos: Acrow Bridge

▲ A new bridge replaces a a concrete roadway that had sunk into the stream over time and often flooded after heavy downpours.

impossible during the rain-heavy winter and spring months in this remote but highly traveled area. A new bridge was needed to provide a safer route during these high-water events so cars would no longer be stranded if they were on the mountain side of the river or washed out trying to cross the existing ford during flash flooding.

Hawaii's Department of Land and Natural Resources (DLNR) decided to construct a permanent bridge at the site, along with a new roadway alignment and a drainage culvert with an inlet and outlet. The 110-ft-long single-lane bridge also includes a sidewalk on one side, separate from the roadway, creating a safe crossing for pedestrians.

The project was made available for bidding in June 2014; general contractor Mocon Corporation finished negotiating substructure design changes with the DLNR and their engineering consultant, Kai Hawaii, in June 2015; and fabricator Acrow began production immediately after design was finalized, then shipped the bridge components to the job site that fall. However, due to rains and foundation pile supply issues, the bridge sat on the job site for about five months before assembly began in early 2016. The success of the project, which opened this past April, was made possible by several key factors, both structural and logistical:

**ABC.** The rapid assembly and installation of the bridge, using only a three-man crew, made it a true accelerated bridge construction (ABC) project.

**Minimal installation equipment.** The simplicity of the structure meant only standard hand tools were required. In addition, because all bolts were non-slip-critical, neither pre-installation verification testing—using a tension calibrator such as a Skidmore-Wilhelm Bolt Testing Measuring Device—nor DTI (direct tension indicator) ASTM F959 washers were required, resulting in a snug-tight approach and lower installation cost compared to concrete or large steel beam bridges.

**Modular construction.** Modular components allowed for ease of shipping, parts staging and assembly in this remote region with a tight build area. Large cranes are not commonly available on Kauai, but this did not pose a problem since the contractor was able to build the structure in situ on falsework in the shallow stream while requiring minimal space for laydown and construction. The modular approach also reduced the potential of damage to the painted sections. All bridge elements were packed into 40-ft shipping containers at Acrow's facility in New Jersey and shipped directly to Kauai.

**Low-to-no maintenance.** Maintenance was yet another issue to consider, especially given the project's location in a remote area with a tropical marine environment. The components were hot-dip galvanized to ASTM A123 for a long life (75+ years with less than 5% surface rust in a tropical marine environment) and completely painted for further rust protection and aesthetic purposes; the individual elements of the structure were shop painted prior to shipping, with touch-up performed on site. Special care in handling and packaging was

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taken in order to minimize the paint scratches that might occur in typical shipping practices.

The duplex coating system provides a higher level of corrosion protection, with the galvanized coating protecting the base steel by providing both cathodic and barrier protection, and the paint acting as a barrier for the zinc layer and significantly reducing its corrosion rate. The maintenance cycle for paint over galvanized steel is typically one-and-a-half to two times greater for paint over bare steel, resulting in a significant cost savings over the life of the structure and a virtually maintenance-free bridge.

**Reduced foundation costs.** Conventional designs would have required larger abutments and, in the case of concrete, longer curing times, increasing the construction schedule and requiring larger cranes—which again, aren't as readily available on Kauai. In addition, longer members would have been more difficult to maneuver over the tight, curving island roads.

**Non-fracture-critical design.** As the bridge's design uses redundant members, it is not fracture-critical and is on a normal bridge inspection schedule. The mostly visual inspection process is particularly easy to perform since nearly every part of the structure is accessible. ■

**Owner**
Hawaii Department of lands and Natural Resources

**Designer**
Kai Hawaii, Inc., Honolulu

**General Contractor**
Mocon, Honolulu

**Steel Fabricator**
Acrow Corporation of America, Parsippany, N.J.

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