



New V-pier installed. The 48-in.-diameter drilled shafts used for the temporary support system installation can be seen. These were later removed to 1 ft above the mudline.

## Replacement of Long Key Bridge V-Piers

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Replacement of the Long Key Bridge V-piers presented several challenges that were overcome during the construction phase of the project. As general contractor, Johnson Bros. Corporation, a Southland Company, used innovative construction techniques to provide a quality repair while keeping safety the top priority.

The project crosses the Long Key Channel, which is within designated Outstanding Florida Waters (an article in the Winter 2017 issue of *ASPIRE*<sup>SM</sup> describes the development and design of this project). Restrictive environmental permits regulated barge activities and required all spud (barge anchor) locations to be surveyed, logged, and reported. Barge spud locations, along with drilled-shaft locations, were required to be premarked and cleared of endangered benthic (sea floor) resources prior to the arrival of barges. To satisfy construction requirements, the general contractor coordinated with the permitting agencies for modification of the permits to reorganize the areas allowed for spudding. The project was successfully completed without any violations of the spudding restrictions or permit requirements.

### Transportation Logistics

The precast concrete V-piers were cast in Tampa, Fla., by Standard Concrete Products and delivered to the jobsite by

specialty trucks. The general contractor looked at several options for the transportation of the monolithic precast concrete V-piers. The simplest approach was to transport the piers to the site via barge and tug, but due to safety concerns an alternate approach was pursued. The general contractor worked with McTyre Trucking and the precast concrete producer to develop a plan to mobilize the piers with specialized trucking. The 135-ton, 16-ft-wide piers required special permits to be delivered via U.S. 1 through the Florida Keys. Blanket permits are not available past Homestead, Fla., and wide-load permits are restricted past Key Largo, Fla., so coordination with the general contractor, the trucking company, the engineer and the construction inspector (Parsons Brinkerhoff), and the Florida Department of Transportation (FDOT) was required to mitigate the concerns and risks associated with the delivery. The Channel 5 Bridge and the Long Key Bridge were required to be closed to traffic while the piers were delivered, so all deliveries occurred between midnight and 2:30 a.m. The Long Key Bridge was closed for only 30 minutes for each unloading operation, which consisted of installing the spreader beams, properly rigging the V-piers, safely lifting and moving them by crane to the barge below the bridge, and disassembling the specialty trailer so it could move off the bridge. All 12 piers were unloaded without incident or unauthorized traffic closures.



Aerial view of the barges in position for V-pier installation. All Photos: James Charles.



Temporary support system in place and removal frame installed on existing V-pier. Jacking system can be seen.



V-pier being lowered from Long Key Bridge to the construction barge at night. Note holes for dowels to drilled shafts.



New V-pier being lifted and placed onto the temporary support system. Hydraulic jack and roller assembly is mounted on the column legs.

## Construction

The temporary support system (TSS) was supported by four 48-in.-diameter drilled shafts for each pier. These were installed using a full-containment system to prevent any discharge of excavated materials or turbid water into the waters of the sanctuary. Due to the local scarcity of structural ready-mix concrete suppliers approved by the FDOT in the Florida Keys, as well as the distance of the plants from the project, concrete was difficult to obtain. A tremie system was fabricated to allow rapid discharge of the concrete into the shafts to reduce on-site truck time. By eliminating the need for boom-pump trucks, the tremie system also allowed concrete to be placed from the Long Key Bridge superstructure during the daylight hours without lane closures. This enabled a more flexible pour schedule while also reducing the impact on the traveling public.

A stanchion system was designed and installed on the barges to allow the TSS to be assembled in two halves prior to mobilization to the piers. Each half of the TSS was hung from the two sides of the barge, at which time the barge was pushed into place next to the drilled shafts. The TSS was then lifted onto the shafts using two cranes. A 45-ton rough-terrain crane had to be used on the front of the barge so that its boom could be lowered to get underneath the bridge and then boomed up between the newer Long Key Bridge and the historic Flagler East Coast Railroad Bridge, which is now used as a fishing pier. The TSS was then lifted off the barge brackets and secured on top of the drilled shafts with the embedded anchor rods. The barge would then move to the other side of the pier and repeat the process for the second half. This process eliminated the need for the TSS to be fully disassembled and reassembled for each pier, reducing the set-up and break-down times.

Removal of the existing V-piers was facilitated by a removal frame—designed by the general contractor’s specialty engineer, A2B Engineering—that supported the four column legs that formed the V. After jacking operations removed the compressive stresses on the columns, the legs were chipped out, and cut at locations under the superstructure and just above the pier cap at the hinge points. They were then rolled out in pairs and lifted to a demolition barge for removal. The pier cap was separated from the existing 42-in.-diameter drilled shafts by wire sawing, then rolled out and lifted by crane onto the demolition barge. The removal frame allowed the existing piers to be disengaged and then removed from under the Long Key Bridge superstructure with only 15-minute traffic closures during the actual jacking operations.

The replacement precast concrete V-piers were required to be positioned with high precision in relation to the existing drilled shafts and the existing Long Key Bridge box-girder superstructure. Four pedestals cast integrally at the top of each precast concrete V-pier needed to be placed directly underneath the diaphragms inside the substructure’s expansion joint segments, while also aligning the 16 dowel holes in the pier cap with the reinforcement cages of the existing drilled shafts. Alignment of the precast pier dowel holes with the existing drilled shaft reinforcement cage was critical to allow coring of the dowel holes through the pier cap into the drilled shafts without damaging the structural integrity of the shafts or damaging the coring equipment. The V-pier was placed on four hydraulic jacks mounted on high-capacity rollers. This allowed the pier to be rolled into place and then adjusted in small increments to the precise position.

After alignment of the V-pier and preparation of the existing drilled shafts, custom-fabricated aluminum grout forms were clamped to the top of the existing drilled shafts and adjusted to exact elevation. The drilled shaft tops and cored dowel bar holes were cleaned, then the V-pier was lowered by hydraulic jacks onto a seal on the top of the clamps. Once the clamps and V-pier were sealed, grouting was begun. After the grout reached its design strength, neoprene bearing pads were slid into location between the pedestals and the bridge superstructure. The overall movement of the superstructure was less than 1/8 in.

The project was completed safely and successfully, allowing the Long Key Bridge, the only land access to the Lower and Middle Florida Keys, to remain open during construction. ▲

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## EDITOR’S NOTE

*For more information on the Long Key Bridge V-pier replacement, see the Winter 2017 issue of ASPIRE<sup>SM</sup>.*