Deep Foundations

JAN/FEB 2021

THE MAGAZINE OF THE DEEP FOUNDATIONS INSTITUTE

U.K. Heavily Burdened Large Diameter Piles

Drilling at end of developing Santa Cruz Island pier

Steel Piles for Island Park's Pier

Located 25 miles off the southwestern coast of California, Santa Cruz Island is the largest of the five islands that make up Channel Islands National Park. The island is rich in cultural history, magnificent landscapes, and unique flora and fauna. Ever since the National Park Service (NPS) and The Nature Conservancy, who own the island, embarked on a multiyear restoration of its natural ecosystem and cultural resources, Santa Cruz Island has become a destination for ecotourists, campers, kayakers and others.

With this influx of visitors, it became obvious that major improvements were needed for the critical park infrastructure of the landing site called Scorpion Anchorage. The previous pier was an elevated aluminum gangway that was inaccessible during low tide. Visitors had to use a ladder and form a bucket-brigade-style line to offload camping gear by passing items person to person along the pier gangway. The go-ahead was given by the NPS to construct the new Scorpion Pier.

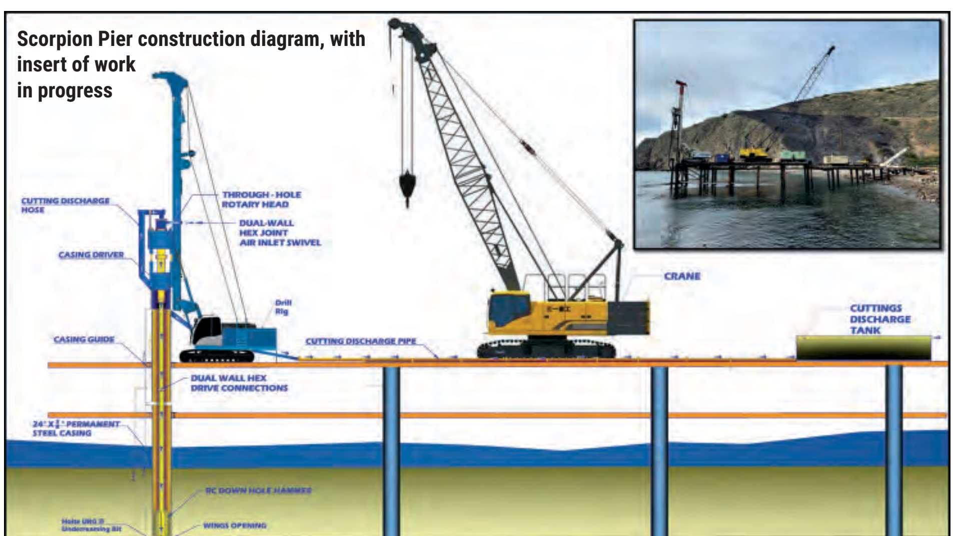
The pier is designed to improve access for boats, passengers and cargo, as well as to protect marine and terrestrial resources, and to preserve the historic character of the surrounding Scorpion Valley.

Jilk Heavy Construction contracted with the NPS to construct a new permanent 300 ft (91.4 m) pier, with D. J. Scheffler & Nye supplying equipment and drilling consultation services for the project under Scheffler & Nye's Peer-to-Peer Partnership program. In November 2019, the contractor set up camp on the island to begin construction.

Pier Specifications

The new Scorpion Pier is an 18 ft (5.5 m) wide structure that broadens out to a 30 ft by 60 ft (9.1 m by 18.3 m) pierhead. The pierhead accommodates an aluminum lift platform that can be raised and lowered by a propane-

Scorpion Pier construction diagram, with insert of work in progress



AUTHORS Josh Jilk, Jilk Heavy Construction and Dale J. Scheffler, D.J. Scheffler & Nye

Preconstruction view of Scorpion Anchorage pier site

powered winch for easier access to the pier from boats, while considering tide and swell conditions.

The timber deck of the pier is an ADA-accessible surface with timber guardrails. To support the structure, 81 piles were installed that are 24 in and 18 in (61 cm and 45.7 cm) in diameter. The steel pipe piles were installed within a 26 in (64 cm) diameter permanent casing. The installation was to a depth of 30 ft (9.1 m) and included the use of pier support piles, berthing piles and lift platform support piles. Because the elevation of Scorpion Anchorage slopes downward to greater depths offshore, the unsupported pile lengths above mudline vary, ranging from 5 ft (1.5 m) at shore side to 40 ft (12.2 m) above mud-line at the pier's most offshore point.

Remote Logistics

Santa Cruz Island has a permanent population of two people, making it a challenging remote location for a major infrastructure construction project. The first logistical challenge was to provide shelter, food and living essentials for a rotating crew of 12 to 25 men, working on a schedule of 4 days on and 4 off. This meant bringing trailers out to the island for housing, implementing a galley kitchen with chefs, and establishing a power source and septic system.

A major construction challenge was transporting a large Soilmec 516 drill rig, crane, excavators, air compressors, hydraulic motors, generators, tools and accessories necessary for the remote project. Loading all this equipment onto barges or vehicle-bearing landing crafts was relatively easy in the Port of Long Beach. However, offloading it in the breaking surf of the island was a different matter. Dive surveys of the ocean floor were undertaken to determine the best way to bring in the barges. Weather and wind conditions, tide levels and the ocean swell had to be considered. Offloading often ended up being a sun-up to sun-down operation.

Site Sensitivities

The careful approach to offloading equipment was just part of strict requirements for construction in an environmentally sensitive national park. Santa Cruz Island is an oceanic outpost that also contains sites with evidence of some of the oldest human activity in coastal Southern California. The island is also home to unique, endemic plants and animals.

Archeological investigations indicate that the Chumash native people occupied the island for at least 9,000 years until the early 1800s. The island Chumash developed a highly complex society dependent on marine harvest, craft specialization and trade with mainland groups. An estimated 10 to 12 historic Chumash Native American villages have been discovered on the island, including one village, Swaxil, located near Scorpion Anchorage.

The introduction of non-native plants and animals in the 19th century caused significant disturbances to the island's natural ecosystem. Island species like native island foxes and bald eagles were soon on the brink of extinction, while nonnative feral pigs and their destructive rooting damaged many archaeological sites. A decades-long restoration project by the NPS helped to bring back many of the island's unique plant, marine and animal species as well as preserve the island's history.

Strict guidelines for the construction process for the new pier had to be in place to protect and preserve the fragile island environment. In order to protect marine mammals, a 1,640 ft (500 m) safety zone was established around the construction site. The NPS had a full-time monitor onsite during all pile installations to look for marine mammals entering the zone. Drilling would come to a stop until the animal left the safety zone. Underwater surveys were also conducted, not only to identify beds of eelgrass that provide

Pier crew relaxing at end of day

food and shelter to a wide variety of marine life, but also to coordinate the best routes for the barges and landing crafts to use to lessen the impact on these vibrant eelgrass ecosystems.

Pier Development

The contractor and equipment supplier/drilling consultant had worked regularly on infrastructure projects throughout California, including the 2011 installation of the pier on neighboring Santa Rosa Island. The challenge with Santa Cruz Island was to find the right method to efficiently install the piles while minimizing the environmental impact. The contractor in this case turned to its drilling contractor peer to help implement the reverse circulation (RC) down-hole hammer (DHH) for installing the steel pipe piles required for all the pier supports. This included Scheffler & Nye providing hands-on training that included practicing with the equipment before work on the island.

The RC DHH method proved to be versatile enough to precisely drill through the encountered subsurface material, which included silty sand, hard silt, coarse gravels, clay, cobble and volcanic rock. The RC approach also allowed for a closed system that moved cuttings out through a discharge pipe and into a cuttings discharge tank.

The ability to capture and remove all the drill spoils without them going back into the ocean prevented water turbidity and helped to create a more environmentally sound process. The method also allowed the NPS archeologist and the Chumash cultural resource protection monitor to observe, sort through excavated materials and identify potential archeological discoveries. During early excavation, the drilling was halted when a few objects were discovered, recovered and documented. The artifacts were later identified as historic man-made artifacts.

ANCHOR QEA

Boring	B-7	Date	5/7/2018
Time	0720	Job	Santa Cruz Island - Scorpion Pier
Job No.	181422-01.01	Logged By	Chad Robinson/Kyle King
Weather	Cloudy, 60 F	Drilled By	Gregg Drilling & Testing, Inc.
Lat:	34° 03' 00.3864"	Drill Type/ Method	Wash Rotary
Long:	-119° 33' 20.7860"	Sampling Method	Split Spoon Sampler, NQ Rock Coring
Elevation:	-13.8	Bottom of Boring	61 feet below mudline
Datum:	MLLW	Bottom of Boring Elv.	-74.8

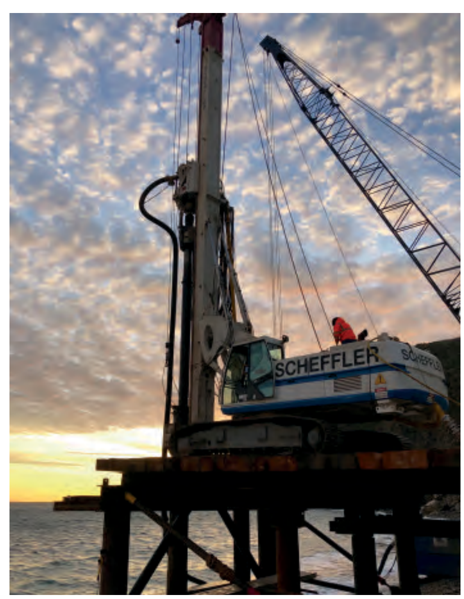
SAMPLE: Sample Number[1]	Recovery (inches)	RQD (%)	Moisture Content (%)	Grain Size (%)	Atterberg Limits (%)	Blow Counts	Depth (feet bgs)	DESCRIPTION/COMMENTS	SUMMARY LOG (USCS)	Elevation (feet MLLW)[2]
S-1	8/18		31.7	G: 3.5 S: 89.3 F: 7.2		1 2 1	1	Very loose, wet, dark gray, silty fine SAND with shell hash		-14.8
							2		SP-SM	-15.8
							3			-16.8
							4	At approximately 4 feet below mudline, driller noted harder drilling		-17.8
							5			-18.8
S-2	9/18					11 7 20	6	Medium dense, wet, dark gray to black, sandy fine to coarse GRAVEL, trace silt, with whole shells and broken shell pieces	GW	-19.8
							7			-20.8
							8			-21.8
							9			-22.8
							10		GP	-23.8
S-3	10/18		10.5	G: 73 S: 22.9 F: 4.1		40 18 20	11	Dense, wet, dark gray, fine to coarse GRAVEL, with some sand and trace silt, whole shells and broken shells		-24.8
							12			-25.8
							13			-26.8
							14	Drilling became very hard at approximately 14 feet below mudline, driller begin using tri-cone bit to clean out and extend casing to depth		-27.8
							15			-28.8
S-4	7/18					5 9 14	16	Medium dense, wet, dark gray, sandy fine to coarse GRAVEL with some silt, broken shells, gravel angular to well rounded (mixed composition)		-29.8
							17			-30.8
							18		GW	-31.8
							19			-32.8
							20			-33.8
S-5	4/18					16 15 18	21	Dense, moist, dark brown, sandy fine to coarse GRAVEL, with some silt (no shells), angular gravel		-34.8
							22			-35.8
							23	Return water consists of clean angular gravel		-36.8
							24	At approximately 24.5 feet below mudline, return water changes to reddish brown		-37.8
							25			-38.8
S-6	7/18					11 18 23	26	Dense, moist, reddish brown, silty sandy GRAVEL, angular gravel (potential completely weathered volcanic bedrock)		-39.8
							27		GP-GM	-40.8
							28			-41.8
							29			-42.8
							30			-43.8

Representative project boring log

Percussion Drilling

RC drilling is a percussion drilling method that utilizes a dual-wall drill pipe that conveys the air to the hammer while evacuating all soil and rock cuttings through the inside of the drill pipe to the surface. Holte Manufacturing, the RC DHH equipment manufacturer, also provided technical support.

A crucial advantage of this drilling approach with the ecologically sensitive Scorpion Pier Project was its absolute control of cuttings. To achieve this, an RC method was designed to specifically meet the project requirements specified by NPS engineers. By taking advantage of bi-directional



Drill rig staged for drilling

rotation, underreaming was performed with a full-gauge down-hole bit (Holte URG system) in targeted formations. Coupling this approach with casing advancement via a casing driver ensured a closed drilling system in which air and cuttings could be controlled throughout the process.

Holte Hex joint connections in the dual-wall drill pipe and the RC DHH design permit rotation in either direction without risk of overtightening connections or tool loss. In RC drilling, the bit has holes that permit cuttings to travel up through the center of the drill pipe, rather than around the drill pipe or casing as in conventional drilling. Compressed air is supplied to the DHH through the dual-wall drill pipe, which provides both the percussive energy and discharge air flow. The air exhausted from driving the hammer is used to evacuate cuttings from below the bit up to the surface via the drill pipe and discharge hose. The casing driver unit also allowed advancement of the casing ahead of the RC bit, when required.

Drilling in this manner provided multiple benefits:

- A closed system was possible that maximized the up-hole velocity and more efficiently utilized air to keep the drill string clean and clear.
- A fraction of the hammer exhaust air could be channeled around the URG wings to keep them clear of debris, and to move cuttings to the bit face. The remaining air could be forced over the bit face to funnel cuttings into the central evacuation pipe.
- Lifting the bit face from the borehole in such a system allowed for easy cleanout through the center cuttings evacuation pipe.

In total, the RC drilling system enabled routing of cuttings in a contained manner during operation, while having the least environmental impact on the island's sensitive ecosystem and archeological sites.

Inserting down-hole hammer into casing at shoreline

Work Scope

The consultant adapted the Soilmec 516 drill rig for the use of an RC DHH to perform the drilling of a total of 81 piles to a depth of 30 ft (9.1 m). The required air pressure for the system was provided by three compressors.

The pier construction included three types of piles: 24 in (61 cm) diameter pier piles and berthing piles with 18 in (45 cm) diameter fender piles. The installed piles were inserted into 26 in (66 cm) diameter permanent casings.

Construction started at the shore side of the pier. The 24 in (61 cm) casing pile bents were installed from shoreline working grade, using the RC DHH system. For the shoreline accessed bents, a 32 in diameter by 10 ft (81.2 cm by 3.0 m) long temporary surface casing was installed at the pile locations with an excavator. This was followed by the placement of the full length 24 in (61 cm) casing that was positioned with a crane. The appropriate RC system, sized for this pile length, was then hoisted and set into the smaller, permanent casing, and the drilling commenced. Once the 24 in (61 cm) diameter permanent casing was installed, the temporary casing was removed.

As the construction progressively moved, bent by bent, in the offshore direction, the remainder of the 26 in (66 cm) diameter permanent casings along with the 24 in (61 cm) piles were installed from a two-level, temporary movable working platform. An integral part of the work platform was the pile placement guides that ensured the precise placement of the casings. The top-level platform accommodated the crane, the drill rig, and the three air compressors whose output was routed through a custom-made manifold arranged in a relatively constrained space.

The most difficult aspect of the pile installation was precise placement of the piles. Tidal surges made exact

Pile drilling guide near shoreline

placement of pile guides difficult. Often, the casing had to be adjusted to ensure correct placement. Also, subsurface conditions could not be reliably predicted. When drilling occurred directly over mud and sand, the pipe would stabilize itself prior to advancing any further. This allowed a casing to be maintained in its planned location. At other times, the pipe was placed on cobble that lead to undesired movement, requiring continuous readjustment for proper casing embedment into a socket.

Inserting down-hole hammer into casing

After each bent was built, the temporary working platform was disassembled and reassembled further out to repeat the installation process. This allowed for the pier's permanent steel structure to be built behind each completed bent before securing the wood decking to the final steel structure.

Conclusion

Visitors to national parks have likely seen signs that state "Pack It In, Pack It Out – Leave No Trace." Using Jilk Heavy Construction's ability to work in remote surroundings and D.J. Scheffler & Nye's technical expertise, the pier pile drilling process for the new pier in a marine sanctuary surrounded by extremely sensitive archeological grounds was finished in a timely fashion in October 2020.

The entire project took approximately a year from planning through completion, with the consultant's participation and peer-to-peer approach helping minimize job costs while maximizing job efficiency. By mid-November of 2020, the finishing touches were completed on Scorpion Pier, which was built to handle storm events and wave action, while improving the safety and efficiency of loading and offloading passengers and cargo for years to come.

Josh Jilk is the project manager for Jilk Heavy Construction, with over 21 years of experience in the marine construction industry. He has managed projects for clients such as the Port of Los Angeles, Port of Long Beach, the U.S. Navy, and for the cities of Santa Monica, Redondo Beach and Ventura in California.

Dale J. Scheffler is the founder and president of D.J. Scheffler & Nye (DJSN), a foundation and shoring contractor specializing in the engineering and installation of deep foundation piles and earth shoring systems. DJSN completes over 200 private and public projects annually, primarily in Southern and Northern California.