CASE HISTORY

ROCK-IT™ ANCHOR SUCCEEDS IN EXTREME CONDITIONS

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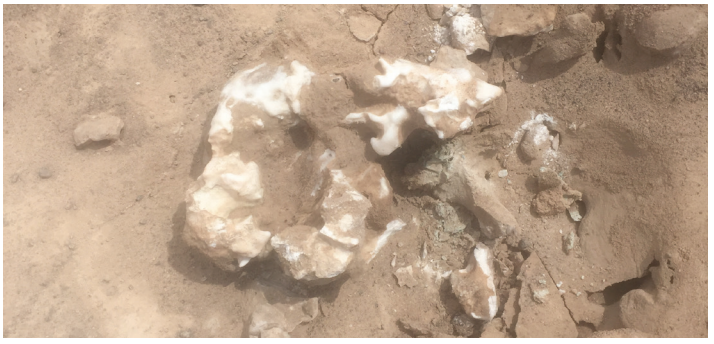
The cover image looks like a moonscape, but, in reality, it is the Atacama desert in Chile. It is the driest, non-polar, desert on Earth, receiving only 0.2 inches (5 mm) of rain per year. In 2017, Hubbell Power Systems (HPS) sent a team there to test a new product, the ROCK-IT™ anchor*, in soil that backhoes can barely scratch. After several days, the testing was complete and successful. At each of the three test sites, 15 to 20 miles (25 to 30 km) apart, the ROCK-IT anchor penetrated to an acceptable depth and provided 45 tons of tensile strength.

NATURAL CEMENT

West of the Andes mountains, the Atacama desert covers 41,000 square miles (105,000 sq km) in a long, thin strip along the Pacific coast. Despite being desolate, construction is currently booming there. Massive solar farms dot the barren landscape and high voltage lines stretch from the power rich areas in southern Chile to the north.



The Caliche can best be described at salt-cemented sand. It is very dense and hard.

Francisco Carcamo, International Business Development Manager for Hubbell Power Systems, Inc. (HPS) explains, "right now, there is a lot of business coming in from Peru to the north and from Bolivia to the north east. In response, Chile is building new infrastructure and expanding its ports and the free trade zones. The north needs electricity, so Chilean companies are building new power lines and solar farms."

Next year, Transelec, the largest transmission company in Chile, plans to add to its existing 5,100 miles (8,200 km) of transmission lines by building a new 220-kV line through the Atacama. The line will be supported by more than 300 towers and Transelec is very interested in a solution that can provide tensile strength to support the towers, without relying on concrete foundations. Consider that the proposed tower locations will be, at a minimum, a two-hour drive from the nearest city (and significantly further in some locations).

"For transmission towers, you need tension anchors, which traditionally means large concrete foundations. If the concrete was mixed at the tower sites, water would have to be transported to 300 towers locations. The other option, of course, is to transport pre-mixed concrete for several hours, through the desert, to the sites," explains Shawn Downey, Project Manager for HPS. Both approaches would be a logistical challenge.

So helical piles would be a good idea, if they could be used. The problem is the soil in the Atacama. It is called Caliche (pronounced ka-lee'-chee) and it is a natural cement found in various regions around the world, including Charleston, WV and Denver, CO in the US. In Chile, the Caliche also contains salt and is almost as hard as rock. That is why the HPS team made the trip--to find out if a helical pile would penetrate the dense soil.

A ROCK-IT anchor is a standard, square shaft, helical pile, but it has a carbide bit welded onto the tip of the shaft.

HPS has a line of helical piles under the brand, CHANCE®, including the Helical Pier Foundation System, which comes in two styles: hollow, round shafts and the more robust, solid steel, rectangular shafts. CHANCE piles are made for strength. The square shaft is fabricated from low-alloy, high-strength steel. The helical plates are made from 80-grade steel with a yield strength of 80,000 PSI. For comparison mild steel has a yield strength of 36,000 PSI. This is strong enough for most jobs, but HPS has a new product that is even stronger. The ROCK-IT™ anchor is designed specifically for very dense, hard soil. It is a standard, square shaft, helical pile, but it has a carbide bit welded onto the tip of the shaft.

PROBLEMS FOLLOWED BY SUCCESS

The test team arrived at the first site after driving for two hours from the nearest city, Iquique (ee-KEE-kay). To test the soil, a backhoe operator did his best, but only managed to dig a shallow hole, a little over a foot deep in the Caliche, before giving up.

The Caliche soil is very dense so digging is difficult, even with a backhoe

Then, it was the team's turn. As expected, the regular, square shaft, helical pile failed to penetrate the soil. And, when the crew tried the ROCK-IT™ anchor, there was a problem.

Shawn Downey provides the details, "The ROCK-IT anchor is being used in the US, but this was the first time we tried it in Chilean soil, which is really very hard. For our first attempt, we used a pile with a steel shaft and three helicals: 8, 10, and 12 inches (200, 250, and 300 mm) in diameter. It did not work;

*The ROCK-IT anchor can also be used as a pile

the helicals were too big. So, I marked up the helicals and took the anchor to a fabricator in the city. He cut them down to 6, 8, 10 inches (150, 200, 300 mm), which is a standard configuration. We just had not brought any with us to Chile. The following day, we successfully installed the ROCK-IT™ anchor.

Using ROCK-IT anchors would minimize the amount site deliveries, greatly simplifying the logistics of building a long transmission line.

Since we only had one with that configuration, we used it repeatedly. We screwed it in and out several times at three different test sites. It worked perfectly." The smaller helical diameter did not limit the ROCK-IT anchor's use in this application," Downey explains, "To choose a helical configuration, we use a software package developed by HPS called HeliCAP® software. It is available to our customers through any of our distributors. The software calculates load capacity, which is dependent on the soil strength and the total area of the helicals. If the soil is dense, you need less helical area and this soil was very dense."

[In theory, a single large helical plate will provide as much compressive and tensile strength as an arrangement of smaller helicals. In reality, it is much easier to drive-in a shaft with multiple, small helicals than a shaft with one large one.]

DRIVING IT HOME

At the three test sites, the team installed and removed the ROCK-IT anchor several times. The ROCK-IT™ anchor augured through the top layer of Caliche and then screwed into the lower layers of soil. "A helical pile is meant to screw into the soil. Each helical has a three-inch pitch and will advance three inches (7.5 cm) per revolution. The ROCK-IT anchor will sometimes penetrate less than that. In the cemented sand we encountered, the ROCK-IT anchor augured through, penetrating about one quarter inch per revolution. The shaft twisted but neither the strength nor the integrity of the steel was effected. (For proof, consider that the team repeatedly used the same anchor and then successfully performed a 45-ton tensile test at the last test site.) Once we were through the hard layer, the anchor screwed in at the proper three inches per revolution," says Downey.

From site to site, the depth of the Caliche varied. In some areas, it only extended down 30 inches (75 cm) or so. At other sites, it extended to about 15 feet (4.5 meters) and installation took longer, but all test installations reached an acceptable depth. Carcamo points out, "The minimum installation depth depends on the diameter of the top helical. To function like a deep foundation, the top plate should be under the surface by five times its diameter. So, a pile with a 10 inch (25 cm) diameter, top helical should be in the ground at least 50 inches (130 cm)." This minimum depth was not quite reached in a few places but testing showed the pile was secure and able to provide 45 tons of tensile strength, which was more than sufficient.

MULTIPLE ADVANTAGES

The successful tests were very good news for future construction projects in the Atacama desert.
Using ROCK-IT anchors would simplify logistics. Supplies for multiple foundations can be transported to the tower sites on one truck and there is no need to mix large amounts of concrete or bring in water tankers.

Another advantage is speed. The ROCK-IT anchor can be installed relatively quickly (compared to other options). More importantly, load can be applied immediately after installation. Concrete takes time to set and reach maximum strength. "Cure time would result in considerable delays in loading for concrete and for micro-piles, which is another foundations option. To construct a micro-pile, a hole is augured into the ground, a steel rod is inserted, and then grouted into place. The tensile strength of this type of anchor comes from the friction between the grout and soil. The problem is you cannot load micro-piles right away. Optimally, you wait 28 days for the grout to fully harden," says Downey. Also, to install concrete foundations and micro-piles, a contractor would need to bring in large construction equipment, like backhoes. ROCK-IT anchors are installed with a small digger with a drive head attachment.

There is one last advantage, which is not at all obvious from looking at the pictures. Despite appearing to be a forsaken desert, every once in a while, it rains in the Atacama and, for a brief time, the desert blooms. The last time was in 2015 and camera crews from around the world flew to Chile to photograph the intense colors. Although it is lifeless most of the time, the Atacama is a environmentally protected area and therefore ground disturbances need to be minimized. Installation of ROCK-IT anchors does not displace soil, so the environmental impact is significantly lower than for other foundations.

Preparing for tensile testing.

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