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DEEP FOUNDATIONS

Rising to the Challenge: A Roof for Arthur Ashe Stadium

Historical Underpinning

Bridge Foundations

Supporting Power Lines

Installation of precast concrete power poles and lattice towers

FEATURE ARTICLE

Photos courtesy Soilmec North America

In Need of More Power

The pioneer founder of Surprise, Ariz., Flora Mae Statler, selected the city's name in 1938 because she "would be surprised if the town ever amounted to much." Back then there were only a few houses and a gas station on a 1 sq mi (2.6 sq km) parcel. Today, Surprise, located in the greater Phoenix metropolitan area, is one of the fastest-growing cities in Arizona. Over the last 10 years, its population has roughly tripled.

This rapid growth has increased demand on the local electric power grid. Arizona Public Service Company has responded by upgrading the nearby electrical substations and adding new 230 kV power lines, creating a more efficient power grid to fully utilize the local nuclear power plant's capacity and to meet the increased demand. This expanded grid may also transmit power from planned solar plants in the future.

Most Wanted Drilling installed the support structures for these new power lines. The company specializes in drilling large-diameter shafts for piers, bridges, and structures such as cell towers and power line poles. Its president, Phil Stilson, used to work for the power company. So it was no surprise that Arizona Public Service Company chose the company for the job.

Phasing in New Power Lines

The new power line structures were constructed in two phases. During the first phase, 65 steel monopoles and 40 concrete power poles were installed to support new power lines that connect two of the expanded substations. The monopoles are solid steel poles with diameters ranging between 5 and 10 ft (1.5 and 3 m) and heights between 150 and 190 ft (45.7 and 57.9 m). The large-diameter monopoles are angled members used to support power lines that change direction; they were designed to transfer wind, weight and line-angle loads directly to the foundation. These massive poles weigh over 80,000 lbs (36.3 tonnes). The small-diameter monopoles support the relatively straight sections of power lines.

Power line pier foundations were installed with a Soilmec SR-45

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Soilmec rigs were used to install all the foundations. A Soilmec SR-40 rig was used to drill the 6 ft (1.8 m) diameter piles, and a Soilmec SR-45 rig was used to drill piles with a diameter up to 9 ft (2.7 m). For the largest piles with a diameter of 10 to 11 ft (3 to 3.3 m) and the most difficult drilling conditions that required more torque, power and crowd force, a Soilmec SR-65 drill rig was used. The depth of the piles ranged between 20 ft and 55 ft (6.1 and 16.8 m), depending primarily on the local terrain.

The precast concrete poles were strictly used as tangent structures for the straight sections of power lines in order to resist small overturning moments. These poles were embedded directly into the ground. The poles have a diameter of 5 ft (1.5 m) and height of 120 ft (36.6 m), so a Soilmec SR-40 rig was used to advance shafts with a 6 ft (1.8 m) diameter and 28 ft (8.5 m) depth. A precast concrete pole was then dropped into each hole and the annular space was filled with concrete.

Powering through Challenges

The installation of these power line pier foundations was challenging. The subsurface consisted primarily of cohesive sand and small gravel that had hardened to near caliche-like conditions. Caving wasn't an issue and the rigs were able to drill the large-diameter piles through the hardened caliche. The installation of quality piles depended on using Soilmec's Drilling Mate System (DMS) – high-tech instrumentation fully integrated with the drill rigs that

Soilmec SR-65 installing 11 ft (3.3 m) diameter piles

Typically these foundations were about 300 ft (91.4 m) apart and were drilled in sequence using the Soilmec rigs. The short distance between piles allowed the rigs to be moved with the mast balanced at the center of gravity at a 45-degree angle over the cab, saving time.

Once a shaft was drilled, a specialized rebar cage with 2-1/4 in (57 mm) diameter, full-length anchor bolts was placed into the hole and concrete was poured. The massive monopole was fastened to the completed reinforced-concrete pier using the 64 threaded anchor bolts.

Phase 2 of the project involved installing the foundations for 69 additional steel monopoles and 41 transmission towers that connect a substation from phase 1 of the project to another expanded substation. The monopoles were sized and installed the same as in phase 1. The transmission towers were four-legged, steel lattice towers used to support the overhead power lines. Each 120 ft (36.6 m) tall tower required four drilled piles with a 3 ft (0.9 m) pile diameter and 23 ft (7 m) average pile depth. Two sizes of lattice towers were used with a center-to-center distance between the legs of either 2 ft or 3 ft (0.6 or 0.9 m).

allowed the rig operators to monitor and control the machines in real time. The DMS collected data from an array of sensors including safety devices, and monitored a variety of drilling parameters which were transmitted to the rig's cab and displayed on an easy-to-use touchscreen interface. DMS helped maintain accurate verticality as they drilled the large-diameter piles.

Managers were also able to analyze the DMS data offline, plotting critical parameters — such as pile profile, concrete pressure and concrete flow — as a function of depth to identify potential construction


Anchor bolts were used to connect the monopoles to the piers

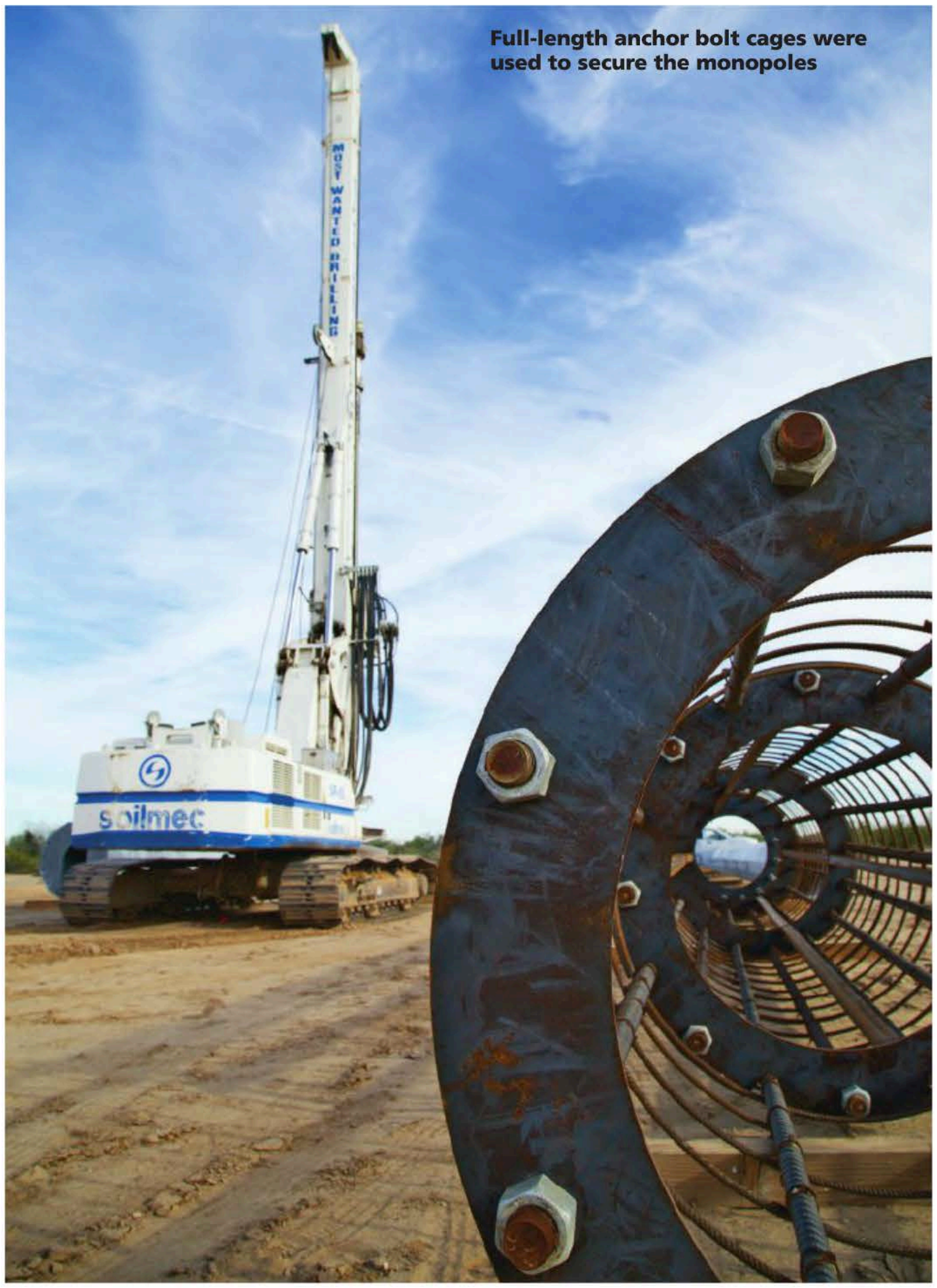
problems like voids in the concrete and to provide proof of construction quality.

There were also several massive rainstorms during the project. During the worst storm, water ran 3 ft (0.9 m) deep along the highways in nearby Phoenix, and flash flooding occurred in the local creeks and gorges. These drenching rains soaked into the ground and saturated the sand, making it difficult to drill, stock supplies and move equipment.

Finally, parts of the desert surrounding the transmission line corridors were protected and closely monitored by the U.S. Bureau of Land Management. This required strict adherence to the right-of-way to access the jobsite, and all the equipment to cut a difficult 90-degree angle to get in and out to the line. Sensitive desert plants and animals were also protected using water trucks to keep the dust down and reclaiming the land under strict guidelines.

Stringing it All Together

Despite all of these challenges, Most Wanted Drilling completed the $10 million project on time and on budget between October 15, 2014, and April 28, 2015. The total project entailed drilling 338 piles and installing 215 power line structures. Soon the 35 mi (56.3 km) of new power lines will deliver electricity more efficiently to the residents of Surprise, Ariz., and beyond.



Full-length anchor bolt cages were used to secure the monopoles