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The Helical Pile Foundation's Time Has Come

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When choosing substation foundations, utilities have traditionally favored concrete piers for their strength and durability. But with the volume and pace of new construction picking up, more are seeking faster, less labor-intensive ways to install a deep foundation. Helical piles may deliver precisely what they need.

With 180 onshore and 17 offshore projects on the drawing board, the U.S. is on pace to invest more than $10 billion a year in new wind energy projects over the next five years, according to a U.S. Energy Department report. The Solar Energy Industries Association, meanwhile, has identified more than 110 gigawatts of large-scale solar projects in development or under construction in the U.S. That is double the amount of solar power the nation currently generates.

The picture emerging for utilities is clear — the workforce responsible for constructing these renewable energy projects is going to be busy in the coming years. New tax credits and other clean energy incentives, particularly those emerging from the Infrastructure Investment and Jobs Act, may make them even busier.

To participate in the market boom, utilities will need to explore ways to complete more projects in less time. A good place to start is with electrical substation design and construction. More specifically, utilities might take a closer look at substation structure foundations.

Rethinking Concrete

Consider that each new solar or wind farm coming online requires the construction of two new substations — one to support the farm itself and the other to connect it to the power grid. The most time- and resource-intensive component of these projects is typically their foundations.

Utilities have historically favored cast-in-place concrete pier foundations to support their substations' equipment. With this time-honored approach, soil is excavated and concreteis poured in the freshly drilled shafts at the site. Once it is set, construction can begin.

While proven and highly effective in many applications, concrete foundations can be challenging to work with. If soil is loose or located near the water table, shafts can be difficult to excavate and keep open until steel reinforcing and concrete is placed. If a substation site's soil profiles or rock depths vary, it can also be difficult to adapt designs once construction starts. In addition, these projects require several components (e.g., drilling, steel rebar cages, concrete supply and labor)

to be scheduled and installed at the same time, adding time, cost and labor to a project. Concrete foundations also can be vulnerable to flaws linked to concrete supply quality, field work quality during drilling and pouring, and environmental conditions, as concrete cure can be susceptible to moisture, freezing and hot temperatures.

There is an alternative that utilities have increasingly relied upon. On substation sites with high water tables, collapsing soils or other unfavorable conditions for cast-in-place concrete piles, more are opting for helical pile foundations instead.

Originally developed in the 1800s to stabilize lighthouses and other structures built on sand and mud where groundwater is present, these prefabricated deep foundations are composed of steel piles that have helical plates welded along their shafts. The piles are twisted into the soil, similarly to how a corkscrew is twisted into the cork sealing a bottle of wine. In the process, the load is transferred from the shaft to the soil through the helical plates and pile itself.

In the past, helical piles have not been used regularly in U.S. transmission and distribution projects. Given the many advantages they offer over concrete foundations, particularly in today's market environment, that may be changing. Those advantages include:

Better quality control — Because helical piles are produced off-site in steel fabrication shops, quality and labor skill is easier to control, compared to that of concrete piles, which require all essential work to be conducted at an outdoor project site. For concrete piles, quality control hinges not only on the skill of the field labor but also the weather conditions. Precipitation and temperatures can impact concrete quality and impede construction schedules. Helical piles, on the other hand, are more weather averse. They can be installed year-round in all kinds of conditions. Helical piles are also designed to a minimum depth and torque that is measured during installation to confirm that the pile will be sufficient for the structure.

Improved subsurface verification — Before designing a concrete pile foundation, engineers obtain and test soil borings from the project site. Subsurface profiles can still run awry, however, when subsurface conditions turn out to be materially different from test location results in some areas. When helical piles are used, soil conditions are monitored continuously and correlated to subsurface soils throughout the installation process, resulting in a clearer picture and more accurate analysis of the piles' load-bearing capabilities.

Fewer labor requirements — Helical piles can be installed by a three-person crew: a surveyor, an excavator operator and a skilled laborer to move and place piles. Working together, a crew can install as many as 20 to 25 helical piles a day. Thus can be a good option in a setting where labor shortages are prominent.

Less disruptive — When excavating shafts for concrete piles, large equipment is used, and soil must be removed and disposed of off-site. That's not the case for helical pile installation, which can utilize equipment that is compact and easily maneuverable, compared to the machinery used to drill bore holes and pour concrete piles. Because of this, helical piles can be a better choice when working in confined spaces or where existing structures are nearby.

Speed of installation — A typical substation project schedule may allow a month or more for concrete foundation installations, plus up to an additional 28 days of concrete cure time. That compares to a week or less needed for the installation of helical pile foundations, which require no

downtime for curing and can accept design loads immediately upon completion. Faster foundation construction means that grounding, conduit and above-grade installations can also begin much sooner with helical piles, helping to speed the entire construction process. The greatest gains are possible when helical pile foundations are designed, engineered, fabricated, installed and constructed all by one team.

Fewer environmental risks — When drilling shafts for concrete piles, soil is removed from holes — and any contaminated soil brought to the surface during excavation must be treated and disposed of off-site. Because helical pile installation does not require soil to be excavated, it causes minimal disturbance to the subsurface and is therefore far less likely to expose any existing environmental contamination at a project site. Its smaller environmental impact makes helical piles an exceptionally good option in environmentally sensitive areas.

Sustainability — If necessary, a helical pile can be removed from a site and reinstalled elsewhere — an option not available with traditional concrete foundations. Even when left in place, helical piles represent a significant step up in sustainability, compared to concrete foundations.

Reduced cost — While material costs for concrete and helical pile foundations can be similar, helical piles offer both labor and schedule savings. Depending on the application, the total cost of helical pile foundations is typically less than that of concrete foundations.

The Bottom Line

Helical piles offer several advantages over traditional concrete deep foundations for substations, including improved project safety. For example, they are similar to a large ground rod, which offers a range of benefits beginning with a safer environment for those working in the vicinity of the substation.

Given this information, all these factors point to a potential increased use of helical pile foundations in the next generation of substations. Demand for speed, efficiency and safety are high, and helical piles deliver on each. The push to adopt this installation method by the transmission and distribution industry is expected to grow as more projects take shape and resource demand is high.

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25919-0122