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1. What are the main components of a helical pile?

The main components of a helical pile are:

- Lead section
- Helical plate
- Coupling connection
- Extension section

2. Is a helical pile a friction pile, end bearing pile or both? Explain.

Helical pile is generally considered an End Bearing pile because it resists structural loads through bearing plates. however, in the case of cylindrical shear mode failure, the load is resisted by the friction between the cylinder encompassed between the top and bottom helices and the surrounding soil, as well as the bottom or the top helix, depending on the axial load direction (compression or tension). In this lecture series, we are discussing small diameter helical piles (shaft diameter equal to or less than 3.5"). For this reason, the friction resistance between the shaft and surrounding soil is very small and is usually ignored in the computation of pile capacity. In most cases, the individual bearing method controls. Therefore, for small diameter shaft sizes, a helical pile is considered an End-or Point -Bearing pile. If, and this is rarely, the cylindrical shear controls, then the pile is considered a combination of Friction and End Bearing pile.
In the case of large diameter shafts, the pile may develop a considerable portion of its capacity from the shaft to soil interface. Therefore, these large diameter helical piles are considered a combination of Friction and End Bearing piles.

3. Name the three methods used to estimate helical pile capacity. Which two are based on traditional soil mechanics?

The three methods used to estimate helical pile capacity are:
1. Individual bearing method
2. Cylindrical shear method
3. Capacity-torque correlation

The first two methods are based on traditional soil mechanics. The third one is an empirical relationship based on load-test results and analysis.

4. What are the benefits of helical piles? Write as many as you can think of.

- Fast installation
- Low mobilization cost due to small installation equipment
- Verify designed pile capacity through torque- capacity correlation during installation
- Low noise impact
- No ground vibration
- Ideal for remedial applications due to minimum damage and disruption in confined spaces
- Provide both tension and compression support
- High uplift resistance to skin friction ratio (expansive soil application)
- Easily field modified
- Immediate loading - no cure time for grout / concrete
- Pile shaft slenderness and ductility helps increase damping of seismic forces
- Minimal spoils, if any, to dispose of

5. Helical piles are considered ideal for sites with expansive soil. Why?

As explained before, helical piles resist structural loads through the bearing plates affixed to the shaft. The heaving or swelling force is directly proportional to the surface area contact between the pile shaft and the swelling soil. Since helical pile's shaft diameter is small, it has less surface area to be influenced by expansive soil. in addition, the adhesion along the central steel pile shaft is much less than that between cast in place concrete or grout and the surrounding soil. helical bearing plates provide resistance to uplift so they can be installed to shallower depth than other conventional piles.

6. Is a helical pile capacity the same in compression and tension? Explain.

The tensile capacity of a helical pile is usually less than its compression capacity. The difference in capacity is explained by the fact that the lead helix rests on relatively undisturbed soil in compression application, wheres as in tension, the helices bears on the soil affected by the installation of both the lead and trailing helices. However, for practical purposes, the helical pile industry chose to use the same capacity-torque ratio for both tension and compression, as stated in AC358.

7. What does the capacity-torque ratio depend on? Explain.

Historically, the capacity to torque ratio,Kt, was determined based on shaft size only. Recent research (Souissi, 2019) has shown that the capacity-torque ratio is affected by:
Shaft size
Final installation torque
Helix configuration
Load direction (compression or tension)
Soil type

8. The torque correlation factor Kt decreases with increasing shaft diameter. Explain.

A helical pile resist structural loads through bearing plates. The installation (applied) torque is resisted by the helices shearing the the soil and by the friction between the soil and the pile shaft. As the shaft size increases. more torque is resisted by the friction between the shaft and soil. Imagine we have two shafts, 2-7/8" O.D shaft and 3.5" O.D shaft, with exactly the same helix configuration and were installed in the same soil to the same depth. The ultimate pile capacity should be the same for both shaft sizes. However, to install the 3.5" O.D shaft to the same depth as the 2-7/8" O.D shaft, more torque is needed. Since the final installation torque is higher for the 3.5" O.D shaft, and since the ultimate capacity is the same for both shafts, then the correlation factor, Kt, for the 3.5" O.D shaft must be lower than that for the 2-7/8" O.D shaft.

9. Explain how the helix spacing affects the behavior of the helical pile?

Helix spacing will affect the failure models used to predict the helical pile axial bearing capacity based on theoretical soil mechanics. If the spacing between the helical bearing plate is large, then each individual helix will act independently and the bearing capacity of the helical pile is equal to the sum of individual capacities of all the bearing plates. This method is called the individual bearing plate method. if the spacing between the helical bearing plates is small, then the helical bearing plates will act more as a group. In this case, the pile capacity is equal to the sum of the side shear along a cylinder encompassed between the top and bottom helices and the bearing capacity of the top or bottom plate, depending on the axial loading direction (tension or compression). This method is called the cylindrical shear method.
The closeness of helical pile plates is a relative term that depends on the pile geometry and the soil. A number of studies has been conducted to determine the spacing where the transition between individual bearing and cylindrical shear occurs. Based on these studies, helical plates spacing of 3 times the bottom helix diameter has been used by most of the helical pile industry. AC358 states a spacing that ranges between 2.4 and 3.6 times the bottom helix diameter. For these ranges of helical plates spacing, the individual bearing will likely control.

10. Two identical piles A & B (same shaft size) but with different helix configurations, were installed to the same torque. From what you learned about helical piles, will these two piles have the same capacity or different capacity? Explain.

Here, we are given the shaft size and the final installation torque. Based on the historical Kt values used in the helical pile industry, the capacity-torque ratio, Kt, is the same for both piles since the historical Kt depends only on the shaft size. Since the final installation torque is the same for both piles, and since the torque correlation, Kt, is the same, then the ultimate capacity ($Q = Kt * T$) will be the same for both piles, A and B.
On the other hand, if we use the newly developed capacity-torque correlation by Souissi (2019), the pile capacities, in this case, will depend on the helix configuration. Single helix and multi helix configurations affect the capacity-torque ratio differently, and therefore, affect pile capacities.