END BEARING ON BEDROCK and HELICAL PILE REFUSAL

Helical piles have been used often and successfully in bedrock end bearing conditions. The practice is quite common. This bulletin provides standard recommendations and precautions regarding end bearing helical plies on bedrock.

Helix Configuration

It is common practice to end bear on hard rock using a single helix bearing plate. Magnum recommends using its unique patented Dual-Cutting Edge helix for end bearing on bedrock. This unique helix design will help improve penetrability and increase the ability to "bite" into the rock and reach maximum torque with less possibility of "spin out". Although it is common to just use one helix for bedrock end bearing, a second or third helix can be used to improve bearing if bedrock is soft, to help advance the pile when crowd is limited, or to support uplift forces (see uplift capacity section below).

Torque Correlations

Torque can be used as a verification of compression capacity of helical piles end bearing on rock. It is often possible to achieve good torque at the top of hard bedrock especially when there is a gradual transition/weathered zone. However, when there is a sharp transition between softer soils and very hard bedrock, helical piles can "spin out" and torque correlations are no longer valid. Spin out is defined as a loss of torque at the soil/bedrock transition and refusal - rotation without further advancement. A loss of torque does not mean reduced bearing capacity; it just means that the capacity of the helical pile cannot be verified using torque correlations.

Refusal Condition

When refusal by "spin out" occurs at the top of bedrock, there are several other means to verify helical pile capacity. One method is to review torque logs for other nearby helical piles. It is reasonable to conclude that the pile with refusal is bearing in similar material as the surrounding piles at the same depth and use the torque logs of surrounding piles to judge capacity.

If all the piles in the same area refuse on bedrock by "spin out" then boring logs should be consulted. If the depth of the helical piles corresponds well to the depth of bedrock shown in soil borings, then the capacity of the helical pile can be estimated by taking the bearing area of the bottom helix times the bearing strength of the bedrock.

Finally, if torque logs from surrounding piles do not exist and geotechnical boring data is limited, then the capacity of a helical pile that has refused by "spin out" can be conservatively estimated using the last torque reading immediately prior to spin out.

Penetration and Helix Sizing

Helical piles are unable to penetrate very hard rock with a SPT blow count much greater than about 150 blows/ft (50/4"), which corresponds to an unconfined compressive strength of about 1,500 psi. Magnum helical piles with dual-cutting edge helix can penetrate softer rock formations such as mudstone, soft limestone, and weak sandstone. The helix should be sized for the strength of the rock and applied loads using the methodology described by (Perko, 2009) in *Helical Piles: A Practical Guide to Design and Installation*. Magnum® Helical Pile Sizing Guide in the (Magnum Piering) product catalog can be used as a guide.

Uplift Capacity

In soft or weak bedrock where good penetration is achieved, the capacity of a helical pile in compression and tension will be similar and both can be verified by torque correlations. When a helical pile bears at a sharp transition between different layers of soil and bedrock then the uplift and compression capacity can vary significantly. Compression capacity will be governed by the strength of the bearing material at or below the helix bearing plates and will correlate with final torque. Uplift capacity will be governed by the strength of the material above the helix bearing plates and will correlate with the toque just prior to the final torque reading.

Pilot Point Shape

It is incorrect to assume a blunt end helical pile is necessary to bear on bedrock. The angle cut pilot point and lead helix edge should bear directly on competent bedrock without modification. The shape of the bedrock surface underground in almost all cases is neither flat, nor smooth, nor horizontal; the bedrock surface is often irregular. It can undulate and contain cracks, mounds, peaks, and buried ravines. It can be covered by cobble and boulders and can be etched by ancient rivers and creeks. It is often weathered at the surface. If one imagines this type of underground landscape, it becomes clear that it is better to use a helical pile with a tapered pilot point and sharpened helix when end bearing on bedrock in order to improve penetration through any weathered material and provide the opportunity for the helical pile to engage or "bite" into the bedrock.

Works Cited

Magnum Piering. (n.d.). *Magnum Piering Products.* Retrieved from Magnum Piering: http://www.magnumpiering.com/engineers/products.aspx

Perko, H. A. (2009). *Helical Piles: A Practical Guide To Design and Installation.* New Jersey: John Wiley & Sons, Inc.