# Creating Acceptance for Helical Foundations

*By Howard A. Perko, Ph.D., P.E.*

The International Code Council (ICC) voted unanimously in June 2007 to adopt AC358 Acceptance Criteria for Helical Foundations and Devices. These new criteria establish a much-needed standard for evaluation of helical piers and foundation brackets. AC358 takes into account not only pier material strengths, but also connections to structures, buckling, corrosion, and soil interaction. Ultimately, the improved evaluation reports resulting from AC358 will standardize capacities, give more confidence to engineers and building officials, and improve manufacturing quality assurance.

*Figure 1: Helical Foundation Installation.*

## Background

A helical foundation is a factory-manufactured steel pile consisting of a central shaft with one or more helix-shaped bearing plate and a bracket that allows attachment to structures. A helical foundation can be designed to resist compression, tension, and/or lateral loads. The typical working capacity of most helical foundations is less than 30 tons in compression and tension. Some helical foundations can support up to 3 tons laterally.

Helical piers are installed by rotating into the ground using a hydraulic torque drive. Installers add extension shafts until the desired torque, depth, and capacity are achieved. Helical piers can be installed with many types of hydraulic machinery, from skid steer loaders to derrick trucks. Helical piers can even be installed by hand-operated torque motors with a structurally braced reaction bar. *Figure 1* shows a typical helical foundation installation rig.

The versatility and mobility of installation equipment makes helical piles an attractive alternative when working within or immediately alongside existing structures. The speed of installation and low mobilization cost make helical foundations appealing for small to medium-sized projects. Because helical piers support both compressive and tensile loads, and can be installed at any angle, they are a valuable geotechnical engineering tool for foundations and earth retention. Helical piles are an ideal deep foundation alternative in areas with expansive, collapsible, and underconsolidated soils, because their slender steel shafts and larger bearing elements make them highly resistant to heave and downdrag.

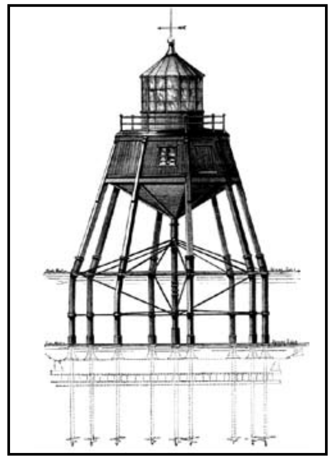

*Figure 2: Maplin Sands Lighthouse.*

Helical foundations were invented in 1836 and used pre-1900 to support hundreds of lighthouses, ship moorings, and marine structures in Europe and the United States. *Figure 2* shows an image of one of the first lighthouse structures supported on helical foundations. Today, helical foundations have practically unlimited applications, including excavation shoring, retaining walls, floor slab support, tanks, new residential and commercial buildings, nature walks, building additions, decks, gazebos, pipelines, and utility structures.

Helical foundations support many commercial buildings and residences. Ford Field in Detroit was constructed in part using helical foundations. Helical foundations also support recent renovations to the University of South Carolina football stadium (*Figure 3*), as well as the underground MRI research facility at Ohio State University. The use of helical foundations has increased exponentially over the last 20 years and is expected to continue to grow.

## ICC Product Evaluations

The International Building Code requires that all manufactured products used in construction, including helical foundations, have a current product evaluation report. ICC-Evaluation Services, Inc. (ICC-ES), the product evaluation arm of the ICC, publishes these reports. Evaluation reports contain product capacity information as well as design and installation guidelines.

There are currently over 50 helical foundation manufacturers in the world. Manufacturing quality varies considerably. Most do not have ICC-ES product evaluation reports.

A small number of manufacturers have a "legacy" evaluation report. Legacy reports are those published prior to the formation of ICC-ES by old code agencies such as IES or BOCA. However, a standard guideline for evaluation of helical foundations did not exist when these reports were written. As a result, they contain limited information. Manufacturing quality is not calibrated to one standard, and they do not address connections to structures, soil interaction, buckling, or corrosion. Instructions for installation vary considerably.

Without a detailed product evaluation report, engineers and building officials need to review an excessive amount of information on every job to assess product acceptance on a case by case basis. This information may include weld inspections, mill run certificates, structural designs, materials testing reports, field test reports, and manufacturing processes.

## Criteria Development

In order to address the lack of clear standards, the Ad Hoc Committee of Helical Foundation Manufacturers (CHFM) formed in early 2005. The committee organized under the rules of parliamentary procedure and consisted of nine independent manufacturing companies: Chance Civil Construction, Magnum Piering, Techno Metal Post, RamJack, Grip-Tite, Earth Contract Products, Cantsink, MacLean Dixie, and Fasteel. The goal of the CHFM was to propose and present universal guidelines for helical foundation product evaluation.

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*Figure 3: University of South Carolina.*

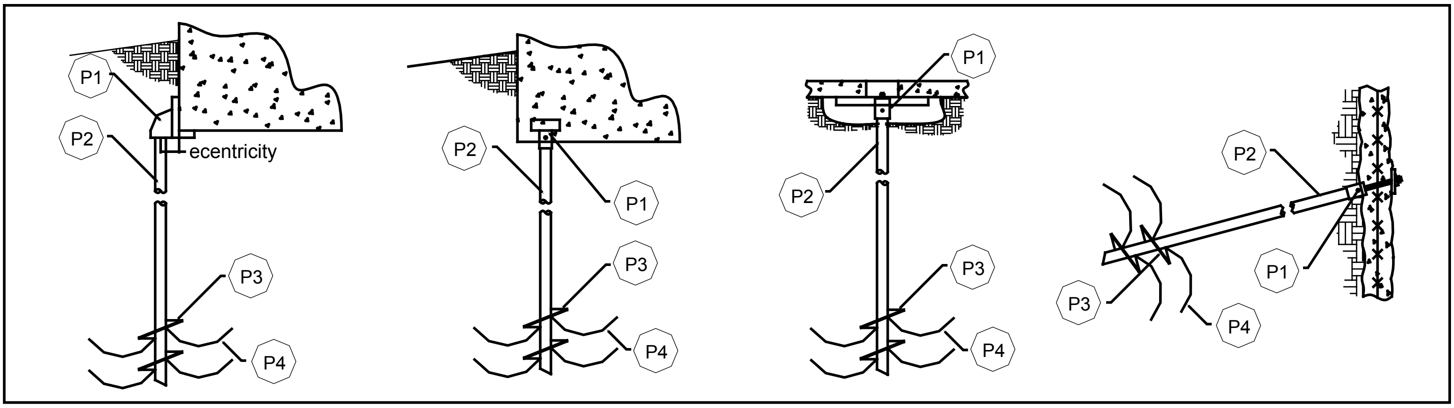


*Figure 4: Primary Strength Components.*

The CHFM met about every two months over the course of two years to put together the criteria that they eventually adopted. Two outside engineering consultants assisted with writing the guideline. In addition, each manufacturer involved its in-house engineers.

After considerable effort, the CHFM presented a working draft of the helical foundation acceptance criteria to the ICC-ES in Whittier, Calif. From there, engineers with the ICC-ES took over development. The criteria underwent much scrutiny, and eventually the ICC reviewed and adopted the document.

## New Evaluation Criteria

The resulting AC358 includes new construction, foundation augmentation, slab support, and tension anchor product applications. Four primary strength components are considered, as shown in *Figure 4*. These include brackets (P1), shafts (P2), helical bearing plates (P3), and soil interaction (P4). Brackets are evaluated for their connection to structures, internal strength, and connection to pier shafts. Shaft evaluation includes tension, compression, and flexure of couplings, as well as shear and torsion. Helical bearing plates are evaluated for punching, weld shear, and torsion. Soil capacity evaluation considers compression, tension, and lateral load resistance.

Engineers can use product evaluation reports based on AC358 to evaluate each of the four primary strength components through a combination of design calculations and product testing. All design calculations need to be traceable to the International Building Code and referenced standards. All product tests need to be conducted by an International Accreditation Service (IAS) accredited laboratory following a published standard. In addition, AC358 introduces a number of new tests such as coupling rigidity, shaft and helix torsion, and helix punching shear.

One of the features of helical foundations that contributes greatly to their popularity and quality is that field capacity can be determined from final installation torque. AC358 goes beyond any previous building codes and considers the relationship between torque and capacity. The criteria delineate between conforming and non-conforming helical foundations. Conforming means the product generally matches the design and configuration of previously manufactured helical foundations, which were used in past research to establish the well-documented capacity-to-torque relationship. In order to be conforming, products must follow a number of rules regarding helix thickness, pitch, diameter, shape, and geometry. Non-conforming products need to undergo considerably more testing to establish capacity-to-torque ratios. The important point is that future evaluation reports should contain a capacity-to-torque ratio that can be used during installation to verify capacity for specific helical foundation products.

Most product evaluation criteria published by the ICC-ES are generated with the assistance of one or possibly two manufacturers. Consequently, many are heavily biased toward a particular product and not necessarily considered an industry standard. The president of the ICC-ES commented after the adoption of AC358 that, due to the extensive involvement of numerous manufacturers and engineers, the criteria for helical foundations is a unique example of how the product evaluation portion of the building codes are supposed to work. AC358 is truly the state of the art with respect to helical foundation design, installation, and manufacturing.

## Future Developments

From this point forward, ICC-ES will use AC358 to prepare all new evaluation reports and for re-evaluation of legacy reports. AC358 is perhaps the most comprehensive criteria ever established for a manufactured foundation system. The higher quality of helical foundation evaluation reports and the resulting increased reliability in capacity should serve as a catalyst for increasing broad acceptance of helical foundations.

Development of AC358 may be a stepping stone to a dedicated helical foundation section in the International Building Code (IBC). Currently, helical foundations are considered specialty piles in the building code and are covered by the general section of IBC Chapter 18. Many of the original members of the CHFM are currently working with the Deep Foundations Institute (DFI) Helical Foundations and Tie-Backs Committee on a new section of the building code that may be incorporated in the next revision. (**www.icc-es.org/criteria/pdf_files/ac358.pdf**)

## Conclusions

The adoption of AC358 is a significant milestone for the helical foundation industry. Having thorough standardized evaluation reports will make it easier to specify helical foundations and may even increase their use. Engineers and building officials can expect higher quality and reliability of helical foundations by insisting on ICC-ES evaluation reports based on the new acceptance criteria.▪

*Dr. Perko was retained by a committee of nine manufacturers as the lead consultant to coordinate development of helical foundation acceptance criteria. Dr. Perko is a principal engineer with CTL|Thompson, Inc., an engineering firm specializing in foundation design and materials testing. He may be reached at* ***hperko@ctlthompson.com****.*