Helical Anchors — The Solution

Mr. Morrissey of GPU Energy provided a solution to the problem. During one of the innumerable site inspections, Mr. Morrissey suggested that the project partners consider using screwed helical anchors for the backstay anchors. Furthermore, if found to be appropriate from an engineering perspective, he volunteered to provide the experienced workers and specialized equipment needed to install the helical anchors. While the tower construction by GPU Energy is much more visually impressive, the helical anchor solution and installation to serve as the backstay anchors were a more significant contribution to the project. The helical anchors were essentially a dream come true for the project. This is another example where utility company practices were incorporated into the design and implementation of the project.

Helical anchors are known as Power Installed Screw Anchors (PISA®). A leader in this technology is the Chance® Company, 210 North Allen Street, Centralia, MO 65240; Phone: 314-682-8414. Chance® has been manufacturing soil anchors for 80 years. There are literally millions of field applications in place. While historically associated with electric transmission lines, the anchors are used in a variety of ways, including retaining wall tiebacks, moorings, street light foundations, pipeline supports, foundation support and underpinning, and boardwalk supports. The usefulness of the technology is gaining recognition outside the transmission line industry. The BOCA® code now includes helical anchors.

The helical anchors can be classified in two general categories. The first category is are power installed screw anchors that provide an anchor to resist a tension load, such as the backstay anchorages on the Pochuck Quagmire Bridge. The second category is helical pier anchors that transmit an axial load to a bearing stratum much like a concrete pier or a pile. Within each category of anchors, there is flexibility in the size of the shaft, diameter, and number of helices. The type of end attachments is also versatile, which allows one to customize the technology to specific needs. The Pochuck Quagmire Bridge utilized the Chance® Helical Pier system as a component of the snowshoe foundation. Photo 34 shows the author holding one-half of the six helix anchors (1.75-inch square shaft screw anchors) used for the backstay anchors. The six helix backstay anchors are detailed on Plan Sheet 7 and in Figure 7.

Photo 34. Tibor Latincsics holding one-half of the Chance® six helix square shaft screw anchor. *Photo courtesy of Mr. Tibor Latincsics.*

The design theory behind both the tension screw anchors and the compression helical piers is called the bearing capacity method. The capacity of the anchor is equal to the sum of the bearing capacities of the individual helices. Each helix bearing capacity is dependent on the unit bearing capacity of the soil stratum it is driven to. Chance® provides a good deal of technical engineering support, and the reader is advised to contact Chance® directly. Among the information Chance® provides are design tabulations, which allow one to relate anchor bearing capacity to standard penetration test blow counts for both cohesive and non-cohesive soils. Such design aids allow one to rough out a concept design prior to spending the time and money on more detail.

The beauty of helical anchors is that they allow one to easily screw through unsuitable soil horizons and install bearing helices into suitable soil. The system works well in environmentally sensitive and inaccessible sites, such as the Pochuck Quagmire. Exploratory soil borings for the Pochuck Quagmire Bridge site indicated that the bearing sand layer was overlain with at least 15 feet of unsuitable muck, organic silt, and clay. Photos 34-40 show how easily the Chance® Helical Pier system dealt with the problems.

Photo 35. Start of the helical anchor installation. *Photo courtesy of Mr. Stephen Klein, Jr.*

As shown in photo 35, a 30-inch deep pilot hole was augered. The location was surveyed and staked out in advance, so labor and machinery were not idle. Note that the GPU Energy drive rig has tracks that do not leave ruts as tire vehicles do. The angle of the gear shaft was adjustable and was set to the 43.3^0 backstay angle required by the design. Mr. Morrissey is preparing the shear pin torque indicator in the lower right of photo 35. The six helix anchor is attached to the rotating driveshaft by a kelly bar adapter and an anchor drive tool. This allows one to match the range of shaft sizes to a variety of installation equipment. Between the two is the shear pin torque indicator.

Photo 36. Pete Morrissey directing the helical anchor installation by Trail Conference and GPU Energy volunteers. *Photo courtesy of Mr. Tibor Latincsics.*

Photo 37 shows the entire assembly and method of installation. The Chance® anchors have the benefit that there is a relationship between torque required to install an anchor and the anchor's capacity under load. There is no guess work associated with the installation. The "rule of thumb" is that a factor of 10 exists between installation torque and ultimate holding capacity. When the torque indicator shows the target level of resistance, the anchor has the target capacity. The Pochuck Quagmire Bridge backstays required 70,000 pounds of holding capacity in order to provide a 3:1 safety factor to the 23,000 pounds tension load in the primary cable under the full live load of 78 PSF over the bridge deck. This would be achieved when the torque indicator read 7,000 pounds. The six helix power installed screw anchors were installed to a shear pin torque indicator reading of 7,500 foot-pounds. It is recommended that pull-out load tests be performed for any installation involving public safety where feasible.

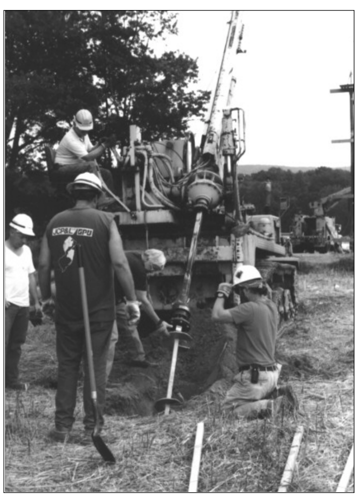

Photo 37. Drive rig, kelly bar adapter, and shear pin torque indicator all in line. *Photo courtesy of Mr. Tibor Latincsics.*

As the six helix anchor was advanced, extension rods had to be added. The extension rods are visible in photos 34, 37, and 40. They come in 5-, 7-, and 10-foot lengths and have male-female bolted couplings. Photo 39 shows Mr. Morrissey bolting a coupling between the two sections of the six helix anchor.

Based on the preconstruction soil borings, the 70,000 pound capacity should have been achieved at a shaft length-depth of 42 feet. The tabulation of the actual installed depths is listed on page 39 as well as shown on Figure 7, page 40, and on Plan Sheet 7 located in the back of this publication.

Photo 38. Helical anchors for the backstay anchorage were installed at 46 degrees. *Photo courtesy of Mr. Stephen Klein, Jr.*

Tabulation of Installed Depths

East Bank - North Pole	=	57'
East Bank - South Pole	=	48'-8"
West Bank - North Pole	=	34'
West Bank - South Pole	=	34'

Photo 40 shows the installation of the Chance® Helical Pier system, which would become an element of the snowshoe foundation for the towers. The single helix pier is in the foreground of the photo. The drivehead with torque indicator is in the center, and extension rods are to the rear. These extension rods terminate in the oval eyes shown in photos 25 and 26 (page 32).

Photo 39. Pete Morrissey bolting the coupling between the two halves of the six helix anchor. *Photo courtesy of Mr. Tibor Latincsics.*

Photo 40. Installation of the Chance® Helical Pier at each corner of the snowshoe foundation. *Photo courtesy of Mr. Tibor Latincsics.*

Although not required for the upright tower construction, the advance installation of the foundation corner helical piers is a good example of how the construction schedule had to be flexible in order to adapt to the weather and availability of the volunteer workforce.

The Chance® screw anchors provided a fast, practical, economical, and environmentally-sound solution to the anchorage requirements of the cable backstays. The six helix anchors cost $2,170 in material. This compares well with the $10,700 in just material costs if concrete deadmen were utilized. Figure 7, on page 40, and Plan Sheet 7 is a diagram of the Helical Anchor.

Bridge Walkway — Stiffening Truss Railing Design and Construction

A design goal of modern suspension bridge design is to keep the roadway or walkway deck stiff or rigid. This provides for a stable walking or riding surface. This is normally done by incorporating stiffening trusses as part of the deck to suspender connections. The twin trusses act to distribute a concentrated load to several suspenders, which in turn distribute the load over a section of the catenary cable. This reduces oscillations in the deck. The trusses are also a component of the deck structural system and in this case, the safety rail system. To some extent, a suspension bridge is a truss bridge supported at intermediate panel points by the suspenders and catenary cables.