WHAT IS A HELICAL SCREW PILE FOUNDATION?

Terms such as Helical Screw Pile Foundation, Screw Piles, Helical Anchors, Screw Anchors, and Helical Piers are often used interchangeably throughout the industry. This manual is no exception.

A Helical Screw Pile Foundation provides the same function as other foundations, i.e. to support or resist loads transferred into the pile by any type of structure. This load can be tension, compression, or lateral. See Section 5 for a detailed discussion concerning loads.

A Screw Pile is simply a steel shaft with one or more helices (formed plates) welded to it. Installation of this type of pile can be compared to that of a self-tapping wood screw. Screw Piles are installed into the ground by the application of rotational torque, usually provided by a hydraulic powered auger system. The axial capacity of the pile is directly related to the torque achieved throughout the last 3 to 4 ft. of installation (i.e. three times the diameter of the largest helix). This *torque vs. capacity* relationship for low displacement piles (i.e. <= 3.50" shaft dia.) provides for an excellent on-site quality control method. This is one of the major advantages of helical screw piles. See Section 14.

A Screw Pile includes three items:

1. Shaft:

    Shaft sizes typically range from 1.25" sq. to 2.00" sq. high strength steel bar and up to 10.75" diameter steel pipe. Expected loads that will result from installation and application normally govern the required size and shape of the shaft. Other factors, such as the method of connecting the pile to the structure, may also influence the required shaft size and shape.

    The shaft has at least four functions –

    a. To provide the required torsional capacity for proper installation
    b. To sustain loads transferred from the helices – during and after installation
    c. To sustain loads transferred from the structure – after installation
    d. To provide the proper connection (interface) to the structure

2. Helices:

    Helical Screw Piles usually include one to six helices. In the case of multi-helical lead sections, the smaller diameter helix always enters the ground first – followed by larger diameter helices or helices of the same size. The difference between diameters of adjacent helices should not exceed 2". The distance between any two helices should be at least three times the diameter of the smaller (or lower) helix. To minimize soil disturbance, helices must be formed to a true helical shape with uniform pitch by matching metal dies.

    The maximum load that each helix can exert against the soil is equal to the effective bearing capacity of the soil times the projected area of the helix.

    The total pile capacity provided by the helices is simply the sum of the individual helix bearing capacities. For low displacement piles (i.e. < = 3.5" dia), skin friction is usually considered negligible and 100% of the pile capacity is assumed to be provided by the helix / soil reaction.

    The Individual Plate Capacity (IPC) method is now recognized throughout the industry as an effective method of predicting the Geotechnical Ultimate Capacity of a Helical Screw Pile Foundation. This method utilizes the Terzaghi's general bearing equation:

$$\mathbf{q_{ult(g)} = A_h \times ((c \times N_c) + (q \times N_q))}$$

The above equation and its application for Helical Screw Pile Foundations will be discussed in detail in Section 8.

Helices have at least four functions –

a. To pull the pile into the soil to the required depth – during installation
b. To transfer load into the soil by means of exerting bearing pressure – after installation
c. To provide the required torsional and bearing capacity – during and after installation
d. To provide the required strength (welded connection) between the helix and shaft.

3. Pile / Structure Interface Connection:

Methods of connecting the pile to the structure depend on the type of structure to be supported. Connections can range from complex welded brackets to holes drilled into the top of the pile. The major consideration for this connection is to assure that there is a clean transfer of load from the structure to the pile.

ADVANTAGES AND BENEFITS

Construction:

- The installation equipment for screw pile foundations is generally smaller, lighter, and less specialized than that required for other types of foundations such as drilled piers, driven piles, and auger cast piles. The cost of mobilizing equipment (move in – move out) is generally much less with helical screw piles than with other types of foundation systems.
- In addition to significant cost savings, the smaller (less specialized) installation equipment, used with helical screw piles, allows for quick responses to situations requiring immediate action.
- The relatively small size of the installation equipment allows for MACLEAN-DIXIE piles to be installed in confined areas (such as inside buildings or areas with low head room clearance) where other conventional means of foundations would be neither feasible nor practical. In some cases the installation equipment can be hand held.
- The installation of screw pile foundations is virtually vibration free, thus allowing installation near existing foundations or footings.
- Onsite Quality Control: By applying the torque vs. capacity relationship (discussed in Section 13), the ultimate capacity of the pile can be determined at the time of its installation.
- The installation of screw pile foundations does not create spoils. This eliminates the time and cost associated with spoil removal and disposal.

Environmental:

- Installation is virtually vibration free.
- Noise level is relatively low.
- Due to the low vibration and noise level, MACLEAN-DIXIE piles can be installed in close proximity to existing structures and populated areas.
- The relatively light (low ground pressure) equipment minimizes surface damage to the area. In some cases the installation equipment can be hand held.

Seismic Loads – New Construction and Seismic Retrofit:

- During seismic events, the flexibility of the steel shafts used with MACLEAN-DIXIE helical pier foundations will better accommodate movement than conventional shallow foundation systems. The advantages of helical pier foundations to resist seismic loads are now recognized in Southern California and other areas prone to seismic activity.

HISTORY

1800's

Alexander Mitchell developed power-installed helical foundations in England in the early 1800's. These power-installed foundations were used in conjunction with the construction of several lighthouses in the English tidal basin.

1950's

Helical Piers began to be used by the electric power industry for guy anchorage and foundations for electrical transmission towers and utility poles worldwide. The primary use of these anchors was to resist tension guy loads. **Joslyn Manufacturing (1954) and Dixie Electrical Manufacturing (1958) began manufacturing helical products for these applications.**

1960's

Helical Piers became the preferred method of guying electrical transmission towers and utility poles. Engineers were beginning to explore other applications for this type of foundation. It became apparent that screw anchors could resist compression loads as well as tension loads.

The Torque vs. Capacity relationship is recognized as a major advantage of Helical Piles. This will be discussed in more detail in Section 14.

1990's

Helical Piles became an accepted method of providing deep foundations. Applications include (but are not limited to) Foundation Retrofits, New Construction, Marine Moorings, Boardwalks, DOT and Tiebacks for earth retaining walls.

2005

On October 28, 2005 MacLean Power Systems (MPS) of Franklin Park, IL, acquired Dixie Electrical Manufacturing Company located in Birmingham, AL. With this purchase, MPS operates out of 11 facilities in 4 countries and employs approximately 1,200 people.

The acquisition of Dixie, together with the MacLean Power Joslyn anchor products business, makes MPS the world's second leading producer of anchoring products for the utility, telecommunications and civil marketplace.

Present:

Since the 1960's, it has become apparent that a screw pile foundation provides the same function as that of any other type of foundation, i.e. to support or resist loads transferred into the foundation by any type of structure. This load can be tension, compression, or lateral.

Terzaghi's general bearing equation is now recognized as an effective method of predicting pile capacity. This will be discussed in detail in Section 8.

The use of helical piles now include, temporary and permanent earth retaining systems (tieback anchors), underpinning system for structures subjected to settlement, pipeline supports, buoyancy control for underground or underwater pipelines, equipment mounts and street light foundations. In addition, helical pile foundations are now being used for new construction. Geotechnical engineers have become increasingly aware of helical screw pile foundations and their applications.

The accepted industry use of Terzaghi's general bearing equation coupled with Torque vs. Capacity relationships have proven to be two of the most important developments in the screw anchor industry.

Future:

At present, most helical pile shafts range in sizes from 1.25" to 2.00" square, and from 2.875" to 10.75" diameter hollow round. The sizes of helices typically range from 6" to 14" diameter. Maximum ultimate pile capacities (not including skin friction) range from 34 to 150 kips. To provide higher capacities, larger helical pile shafts and helices will be required.

Geotechnical textbooks will begin to include the design and application of helical piers.