

# An Introduction to Helical Soil Nails

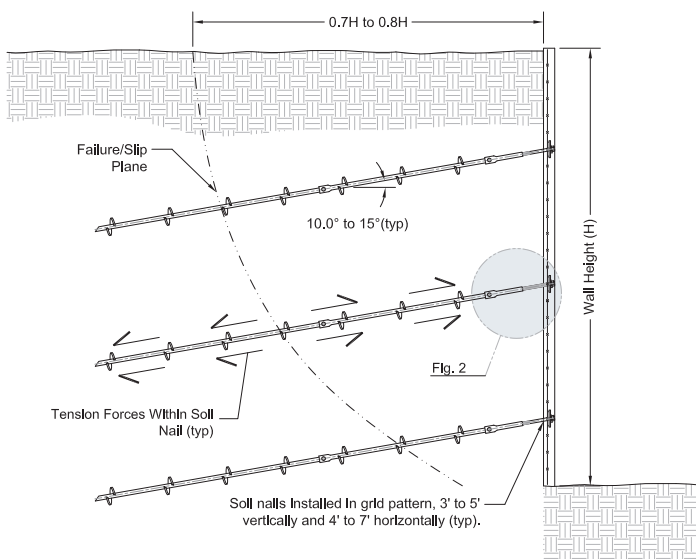
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Soil nailing is a method of earth retention that relies on a grid of individual reinforcing strands or members installed within a soil mass to create an internally stable gravity wall/retaining system. Soil nail wall technology began in Europe with use of the New Austrian Tunneling Method in rock formations in 1961. The technology then carried over to applications involving unconsolidated soil retention, primarily in France and Germany. Soil nail walls were first used in North America for temporary excavation support in the late 1960's and continued to gain recognition and acceptance during the 1970's and 1980's for higher profile projects including highway applications. Much of the soil nail wall research performed in North America was funded by the Federal Highway Administration (FHWA) and other state highway agencies during the 1990's. Although helical piles have been used as tiebacks since the early 1950's, helical soil nails are a relatively new alternative to their grouted counterparts.

Excavation, soil nail installation and application of wall facing is completed in steps from the top of the wall downward. The construction sequence for a typical helical soil nail wall includes:

- Initial vertical excavation of about 3 to 5 feet deep depending upon design parameters and soil conditions
- Installation of the first row of helical soil nails to the required inclination angle, torque and embedment length
- Placement of drainage medium (if required)
- Placement of wall reinforcement and bearing plates
- Placement of shotcrete to the required design wall thickness
- After shotcrete has cured, repeat sequence for successive rows of soil nails. Continue process to the final design depth (wall height).

Figure 1: Helical Soil Nail Wall Installation



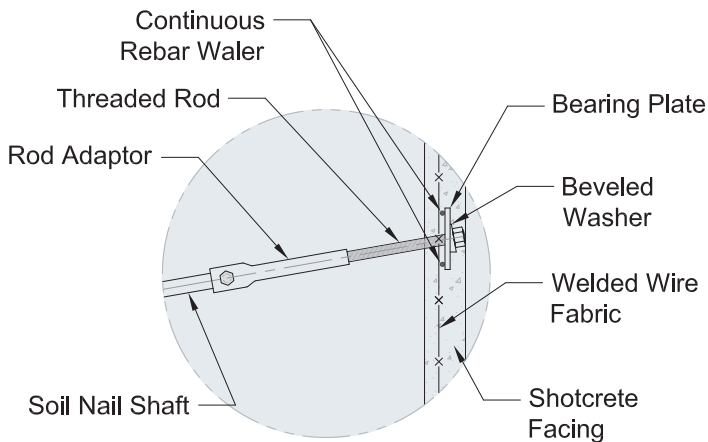
A helical soil nail typically consists of square shaft lead and extension sections with small diameter (6 to 8 inches) helix plates spaced evenly along the entire shaft length (See Figure 1). Helical soil nails are typically installed in a grid pattern, spaced 3 to 5 feet vertically and 4 to 7 feet horizontally, and are advanced by application of torque.

Helical Soil Nail Installation; Placement of Drainage Strips and Reinforcing



Helical soil nails are passive bearing elements which rely on movement of the soil mass to mobilize the soil shear strength along the nail. As a result, soil nail walls typically experience more lateral movement than tieback walls of similar height. As a general guide, the soil mass located between the failure plane and the wall facing may slump approximately 1/8-inch laterally and 1/8-inch vertically for each 5-foot depth of excavation. Any structure, utility, roadway, etc. that would be impacted by the wall movement and/or failure plane should be considered in the design phase. By allowing this movement, the highest stress in the soil nail is near the failure plane, centered between the opposing tensile forces. Conversely, the highest stress in a tieback is at the wall face. Therefore, soil nails have less nail head force than tiebacks for a similar size wall, which results in

Figure 2: Nail Head to Wall Detail



potential cost savings by using soil nails due to reduced wall thickness requirements.

The design procedure for helical soil nails is similar to that for grouted nails. For a helical soil nail, the bond stress with the soil is assumed to act along a cylindrical surface area defined by the outside edge of the helix plates. Bearing capacity of the soil nail is determined using the Individual Bearing Method and is correlated to bond stress by:

$$q_u = \frac{Q_u}{L\pi D_h FS}$$

Where,

- $q_u$  = Bond Stress (psi)
- $Q_u$  = Bearing Capacity of the Helical Soil Nail by Individual Bearing Method (lb)
- $L$  = Soil Nail Length (in)
- $D_h$  = Helix Diameter (in)
- $FS$  = Factor of Safety for Uncertainties in Soil Conditions (Typically 1.5 to 2.0 Based on Quality of Soil Information)

Helical soil nail walls are used most often in temporary shoring applications, with reinforced shotcrete the most common temporary wall facing material. Shotcrete is concrete conveyed through a hose and projected through a nozzle at high velocity onto a working surface. The shotcrete is applied/sprayed in thin lifts until the design thickness requirement is met for the wall. For temporary wall applications, the shotcrete is typically applied to a thickness of 3 to 4 inches. Internal reinforcement of the shotcrete may consist of welded wire fabric (WWF), steel reinforcing bars (rebar), or fiber reinforcement. WWF with rebar walers at the nail heads is typically favored due to ease of installation (See Figure 2).

Permanent helical soil nail walls may either have an additional thickness of shotcrete applied or another facing attached to the temporary shotcrete layer. For permanent soil nail walls with shotcrete facing, the typical wall thickness varies from 6 to 12 inches, not including the thickness of the temporary facing. Cast in place and precast concrete facings can also be used in conjunction with the temporary shotcrete wall facing. Facings can be attached to the shotcrete wall to form decorative facades.

Helical soil nails may be the most economical and/or feasible solution for your next earth retention project. The information presented herein is simply an overview. Please contact FSI if you have any questions regarding helical soil nail design or installation.



### Don Deardorff, P.E. Senior Application Engineer

Don provides preliminary design assistance for installing contractors, engineers, architects and other design professionals. He specializes in large and challenging commercial and industrial applications involving helical piles, helical tiebacks, soil nail walls or hydraulically-driven push pier systems. Don has performed over 1,100 helical or push pier designs during his tenure as a helical design professional. With his industry knowledge and research experience, Don also assists with product development and verification testing, and the development of technical documents and presentations.