Underpinning Existing Foundations

Underpinning is the process of supporting an existing foundation using a foundation pier or piling system. Underpinning is used to stabilize foundations due to concerns over foundation movement or for bolstering an existing foundation so that new loads can be added. A common method of underpinning is to attach helical piles to existing concrete using a steel bracket. Helical piles represent a cost effective underpinning solution. Benefits of helical piles include exceptional uplift resistance, no drill spoil, no concrete delays, low noise, and no vibrations. Helical pile design and construction criteria for underpinning are as follows:

Helical Piles

1. Helical piles are available in a variety of sizes and configurations depending on loads and type of structure. Helical piles commonly used in underpinning applications typically have a shaft dimension of up to 3.5 inches and allowable capacity generally less than 20 tons. Many "off the shelf" brackets and underpinning systems are available in this capacity range. For larger commercial and industrial applications, custom brackets are available but require project specific engineering. Given advantages of redundancy and closer spacing, it is generally more dependable to use a larger number of smaller underpinning piles on projects with heavy loads rather than fewer high capacity underpinning piles.

2. Project structural engineer should locate helical piles on foundation drawings and identify required compression and tension capacity. Helical piles should be designed and sized by a specialty pile engineer licensed in the project state. Otherwise, helical piles should be proof tested by applying load to the pile through the bracket. Proof testing verifies capacity of the pile, bracket, and connection to structure. Proof testing should be performed one pile at a time to 100% of required pile capacity provided there is sufficient dead load.

3. The number and size of helical bearing elements should be as required to achieve bearing in a base line stratum consisting of [describe bearing stratum] with a standard resistance blow count (N_{70}) of [report average N-value]. A minimum factor of safety of 2.0 is required for bearing and pullout capacity determination.

4. As a base line for bid purposes, properly sized helical piles can be expected to achieve bearing at a depth below ground surface of [depth of stratum or range] plus the aggregate spacing between helical bearing elements. To ensure proper embedment for pullout and to resist effects of frost and shrink/swell

soils, we recommend piles have a minimum depth of [state minimum depth if any].

5. Helical piles and brackets used for permanent underpinning are typically hot-dip galvanizing in accordance with ASTM A153. Helical piles and brackets used for temporary underpinning can be bare steel.

6. Helical piles used for underpinning are generally not relied upon to resist lateral loads. Lateral loads, if any, should be resisted by other means such as separate helical anchors, tie-backs, floor slabs, or other bracing.

7. Per IBC, all piles shall be laterally braced. This is especially important for slender underpinning piles. Lateral bracing can be achieved by arranging three or more piles under an isolated column or by staggering piles on each side of long walls or grade beams. Exceptions are light residential construction, wherein lateral bracing often can be achieved by internal strength of stem walls and floor systems.

8. Tolerance for helical pile placement is typically +/-2 inch horizontal, +/-1/8 inch elevation, and 3 deg orientation/inclination. Helical piles installed out of tolerance often can be removed and repositioned.

9. Installation torque and depth should be measured and recorded during helical pile installation at 3-foot intervals. Torque measurement equipment should be calibrated annually to NIST standards. Installation torque should be used to determine termination depth and pile acceptance by applying commonly recognized capacity:torque relationships such as those provided in Perko (2009) or ICC-ES AC358. Until a proper final torque is achieved, continue to add extension sections to further advance the helical pile.

10. Recognized capacity:torque relationships rely on a proper shaped helical bearing elements. The helical bearing element should be perpendicular to the shaft along and leading and trailing edges should be parallel. All helical bearing elements should have the same pitch.

11. If refusal occurs prior to achieving the minimum depth, helical piles often can be reversed in direction and worked up and down in an attempt to break through the obstruction. Obstructed piles also may be removed and modified or replaced to have fewer helical bearing elements. If the obstruction is shallow, it may be feasible to remove it by surface excavation; backfill and compact prior to pile reinsertion. If the obstruction is deep, a pilot hole made with a rock drill may be necessary; the diameter of the pilot hole should be no more than 1/2 inch larger than the diameter of the helical pile shaft.

12. If refusal occurs after reaching the minimum depth, helical piles can be deemed acceptable provided the depth of helical bearing elements corresponds to the depth of suitable bearing stratum in the boring logs and/or helical piles installed nearby achieved required torque at similar depth as the obstructed pile.

13. Due to the importance of helical bearing element shape, configuration, and design in torque correlations and field capacity verification, we recommend helical piles manufactured by an ISO9001 accredited quality manufacturer with history of product testing. A preferred manufacturer with 30 year history in design and manufacture of underpinning systems along is Magnum Piering, Inc. (www.magnumpiering.com, 800-822-PIER).

14. Installation of helical piles should be observed by a representative of [name of geotechnical firm] to document pile depth, pile size, and installation torque.