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ESR-3370

Issued 03/2017
This report is subject to renewal 03/2018.

DIVISION: 31 00 00—EARTHWORK
SECTION: 31 63 00—BORED PILES

REPORT HOLDER:

PATRIOT FOUNDATION SYSTEMS, LLC

30427 COMMERCE DRIVE
SAN ANTONIO, FLORIDA 33576

EVALUATION SUBJECT:

PATRIOT FOUNDATION SYSTEMS HELICAL FOUNDATION SYSTEMS

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Section: 31 63 00—Bored Piles

REPORT HOLDER:

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EVALUATION SUBJECT:

PATRIOT FOUNDATION SYSTEMS HELICAL FOUNDATION SYSTEMS

1.0 EVALUATION SCOPE

Compliance with the following codes:

2015, 2012, 2009 and 2006 *International Building Code®* (IBC)

Properties evaluated:

- Structural
- Geotechnical

2.0 USES

The Patriot Foundation Systems (PFS) helical foundation systems are used either to underpin foundations of existing structures or to form deep foundations for new structures; and are designed to transfer axial compression and axial tension, from the supported structures to suitable soil-bearing strata.

3.0 DESCRIPTION

3.1 General:

The PFS helical foundation systems consist of a helical pile and a bracket that allows for attachment to the supported structures. Each helical pile, consisting of a lead section and one or more extension sections (optional), is screwed into the ground, by application of torsion, to a depth that conforms to project requirements for avoidance of unsatisfactory subsurface conditions and that ensures a suitable soil- or bedrock-bearing stratum has been reached. The bracket is then installed to connect the pile to the supported structure. The bracket can be either a side-load bracket as described in Section 3.2.4 or a new construction bracket as described in Section 3.2.5.

3.2 System Components:

3.2.1 Lead and Extension Sections: The PFS helical pile lead sections consist of single or multiple (two or three) helical-shaped circular steel plates (helix plates) factory-welded to a central steel shaft. The depth of the helical piles in soil is typically extended by adding one or more steel shaft extensions that are mechanically connected together by through bolts, to form one continuous steel pile. The extensions do not include helical bearing plates. Both the lead section and the extension sections are round hollow structural steel sections, HSS2.875x0.217. Lead section (Model No. PF300) come in 7 foot lengths (2134 mm) and extension sections (Model JW300) are available in 3, 5 or 7 feet (914, 1524 or 2134 mm) nominal lengths. The lead and extension sections have a $2^{7}/_{8}$-inch (73 mm) outside diameter and a 0.217-inch (5.5 mm) nominal wall thickness. The leading end of a lead section is cut to a 45° angle from the shaft longitudinal axis. Figure 1 illustrate a typical helical pile lead section and an extension. Tables 1A and 1B provide a description and allowable soil capacities for the pile lead and extension sections, respectively. Table 2 describes the mechanical properties of 2.875-inch-diameter helical shafts.

3.2.2 Helix Plates: Each circular, helical, steel bearing plate (helix) is split from the center to the outside edge with spiral edge geometry. Each helix is formed to a clockwise downward spiral with all radial sections normal to the shaft's central longitudinal axis with a 3-inch (76.2 mm) pitch. The pitch is the distance between the leading and the trailing edge. The helix plates for the PFS helical piles are 0.375 inch (9.5 mm) thick and have an outer diameter of 8, 10, or 12 inches (203, 254, 305 mm). For single helix piles, the helix is factory fillet-welded to the leading end of lead sections. See Table 1A and Figure 1 for helical pile configurations. For multiple helical pile combinations, two or three helices are factory-welded to the lead sections. Helix spacing along the shaft is 3 times the helix diameter of the leading helix. Helix plates are arranged along the shaft such that they track the same path as the leading helix. The leading helix must be of an equal or smaller diameter than the helix immediately on top of it. The helix plate capacities for resisting axial compression and axial tension loads are shown in Table 5.

3.2.3 Coupling: A coupling is factory-welded to the bottom end (or lower end) of an extension section in order to connect to the upper end of the lead section or the other end of an extension section. The coupling consists of a 14-inch-long (356 mm), round HSS2.375x0.276, with an outside diameter of 2.375 inches (60 mm) with a 0.276-inch (7.0 mm) nominal wall thickness. Two $^{13}/_{16}$-inch (0.81 mm) holes are drilled in the coupling and these holes are aligned with the two holes drilled in the lead section or extension section. Two $^{3}/_{4}$ inch-diameter (19.05 mm), steel heavy hex bolts, and two matching steel heavy hex nuts are required for each coupling installation.

3.2.4 Side Load Bracket: The PFS side load bracket is a Type A (side load) bracket as defined in Section 3.10.1 of AC358. The bracket is used to support compressive load from existing concrete foundations. Each bracket consists of a factory manufactured bracket subassembly, a steel lifting T-bar, two threaded steel rods with four matching steel nuts and two washers, and two bracket bolts with matching steel nuts, with two washers; and is hot-dip galvanized in accordance with ASTM A123. The shelf portion of the bracket subassembly is placed underneath the foundation and measures 12 inches (304.8mm) wide by 8 inches (203.2 mm) deep. The face of the bracket subassembly is placed against the side of the foundation and is measures 12 inches (304.8 mm) wide by 8.5 inches (215.9 mm) high. The shelf and face portions of the bracket subassembly are made from steel measuring $^{3}/_{8}$ inch (9.5 mm) thick. Overall, the bracket subassembly is 15 inches (381 mm) in height by 12 inches wide (305 mm). A steel lifting T-bar and two $^{7}/_{8}$ inch diameter (22.2 mm), 14 inches long (355.6 mm), steel threaded rods with four matching, 0.875-inch-diameter (22.2 mm), heavy hex steel nuts and two matching round, 2.25-inch-diameter (57.15 mm), heavy steel washers are used to ensure that the bracket is in firm contact with the supported foundation. The lifting T-bar consists of a 10-inch-long-by-2.5-inch-by-$^{1}/_{4}$-inch-thick (254 mm by 63.5 mm by 6.4 mm) rounded corner square steel tube factory-welded to a 24-inch long (610 mm), 2¼-inch-outside-diameter by 0.118-inch nominal wall thickness (57 mm by 3 mm), steel pipe, which is sized to be inserted into the top portion of the lead or extension section. Two ¾-inch (19 mm) diameter bracket bolts as described in Section 3.3.6 and two matching nuts must be installed on either side of the extension or lead section to brace the bracket to the shaft. The steel bar and steel pipe conform with the material properties shown in Section 3.3.4 of this report. (See Table 1 and Figure 2).

3.2.5 New Construction Bracket: The PFS new construction bracket is a Type B (direct load) bracket as defined in Section 3.10.2 of AC358. The bracket is used to support compressive and tension loads from the pile and concrete foundations. The bracket has a ¾-inch-thick-by-8-inch-wide-by-8-inch-long (19 by 203 by 203 mm) bearing plate with two predrilled holes. The steel plate is factory-welded to a $3^{1}/_{8}$-inch-outside-diameter (79 mm) by $^{1}/_{8}$-inch-thick (3 mm) steel sleeve measuring 7 inches (178 mm) long. The sleeve has two predrilled $^{13}/_{16}$-inch diameter holes used to receive two ¾-inch (19 mm) diameter bolts for through-bolting to the top of the helical shaft. The bolts and nuts must be as described in Section 3.3.6 of this report. (See Table 1 and Figure 3).

3.3 Material Specifications: Steel parts and components, including brackets and bolts, are galvanized according to ASTM A123.

3.3.1 Lead and Extension Shafts: The shaft lead and extension sections are round seamless tubes conforming to API 5CT, Grade J-55, having a minimum yield strength of 55,000 psi (379 MPa) and a minimum tensile strength of 75,000 psi (517 MPa).

3.3.2 Helix Plates: The helix plates are carbon steel conforming to GB/T 3274 Q235B, having a minimum yield strength of 50 ksi (346 MPa) and a minimum tensile strength of 69.6 ksi (480 MPa).

3.3.3 Coupling: The coupling section complies with ASME SA 106/95, Grade B, having a minimum yield strength of 35,000 psi (240 MPa) and a minimum tensile strength of 60,000 psi (415 MPa).MPa).

3.3.4 Side Load Bracket: The side load bracket subassembly is made from carbon steel conforming to GB/T 3274 Q235B, having a minimum yield strength of 50 ksi (346 MPa) and a minimum tensile strength of 69.6 ksi (480 MPa). The threaded rods conform to specification ISO 898-1, Grade 10.9, and are 14 inches (355.6 mm) long and $^{7}/_{8}$ inch (22.22 mm) in diameter. For installation of threaded rods, 0.875-inch (22.2 mm) steel nuts comply with ASTM A563, Grade DH, and the 2.25-inch-diameter (57.15 mm) washers comply with ASTM F436. Bracket bolts are in compliance with ASTM A325, and are ¾-inch (19 mm) diameter. Nuts for the bracket bolts comply with ASTM A563, Grade DH.

3.3.5 New Construction Bracket: The steel plate and sleeve used in this bracket comply with GB/T 3274 Q235B, having a minimum yield strength of 50 ksi (345 MPa) and a minimum tensile strength of 69.6 ksi (480 MPa).

3.3.6 Coupler, Side Load Bracket and New Construction Bracket Bolt: All bolts conform to ASTM A325, Type 1, and are ¾ inch (19.05mm) in diameter. Nuts for the bolts comply with ASTM A563, Grade DH.

4.0 DESIGN AND INSTALLATION

4.1 Design:

4.1.1 General: Engineering calculations (analysis and design) and drawings, prepared by a registered design professional, must be submitted to and approved by the code official for each project, and must be based on accepted engineering principles as described in IBC Section 1604.4, and must conform to Section 1810 of the 2015, 2012 and 2009 IBC (Section 1808 for the 2006 IBC). The engineering analysis must address helical foundation system performance related to structural and geotechnical requirements. The calculations must address the ability (considering strength and stiffness) of the supported foundation and structure to transmit the applied loads to the helical foundation system and the ability of the helical piles and surrounding soils to support the loads applied by the supported foundation and structure. The design method for the steel components is Allowable Strength Design (ASD), described in IBC Section 1602 and AISC 360 Section B3. The design method for the concrete components is Strength Design (also called LRFD) as described in IBC Section 1602 and ACI 318, and must comply with Section 3.7.1.2 of AC358 in order to utilize the ASD capacities described in this evaluation report. The design method for soils is ASD as prescribed in IBC Sections 1801.2 and 1602.

The structural analysis must consider all applicable internal forces (axial forces, shears, bending moments and torsional moments, if applicable) due to applied loads; eccentricity between applied loads and reactions acting on the pile-supported structure; the loading exerted on the supported structure by the connection brackets; and the design span(s) between helical foundations. The loading exerted on the supported structure by the connection bracket is equal in magnitude and opposite in direction to the force in the pile. A small lateral force is developed at the supported structure if the pile shaft is not perfectly plumb but within the permitted inclination from vertical of ±1°. The lateral force is equal to 0.0175 times the axial force in the pile, and must be resisted by the supported structure or other structures that are connected to the supported structure. The result of this analysis and the structural capacities must be used to select a helical foundation system.

The minimum pile embedment into soil for various loading conditions must be determined based on the most stringent requirements of the following: engineering analysis; tested conditions and specified minimum pile embedment described in this report; the site-specific geotechnical investigation report; and site-specific load tests, if applicable.

For helical foundation systems subject to combined lateral and axial (compression or tension) loads, the allowable strength of the shaft under combined loads must be determined using the interaction prescribed in Chapter H of AISC 360.

The geotechnical analysis must address the suitability of the helical foundation system for the specific project. It must also address the center-to-center spacing of the helical pile, considering both effects on the supported foundation and structure and group effects on the pile-soil capacity. The analysis must include estimates of the axial tension and axial compression of the helical piles, whatever is relevant for the project, and the expected total and differential foundation movements due to single pile or pile group, as applicable.

A written report of the geotechnical investigation must be submitted to the code official as part of the required submittal documents, prescribed in Section 107 of the 2015, 2012 and 2009 IBC (Section 106 for the 2006 IBC), at the time of the permit application. The geotechnical report must include, but not be limited to, the following information:

1. A plot showing the location of the soil investigation.
2. A complete record of the soil boring and penetration test logs and soil samples.
3. A record of the soil profile.
4. Information on groundwater table, frost depth and corrosion-related parameters, as described in Section 5.0 of this report.
5. Soil design parameters, such as shear strength, soil bearing pressure, unit weight of soil, deformation characteristics and other parameters affecting pile-support conditions as defined in Section 1810.2.1 for the 2015, 2012 and 2009 IBC (Section 1808.2.9 for the 2006 IBC).
6. Confirmation of the suitability of helical foundation systems for the specific project.
7. Recommendations for design criteria, including but not limited to, mitigation of effects of differential settlement and varying soil strength; and effects of adjacent loads.
8. Recommended center-to-center spacing of helical pile foundations, if different from spacing noted in Section 5.0 of this report; and reduction of allowable loads due to the group action, if necessary.
9. Field inspection and reporting procedures (to include procedures for verification of the installed bearing capacity, when required).
10. Load test requirements.
11. Any questionable soil characteristics and special design provisions, as necessary.
12. Expected total and differential settlement.
13. The axial compression, axial tension and lateral load soil capacities if values cannot be determined from this evaluation report.

There are four primary structural/geotechnical elements associated with the helical foundation system: bracket capacity, pile shaft capacity, helix plate capacity and soil capacity, which are described in Sections 4.1.2, 4.1.3, 4.1.4, and 4.1.5, respectively. The allowable capacity of overall helical foundation system is described in Sections 4.1.6 and 4.1.7.

4.1.2 Bracket Capacity (P1):

The concrete foundations must be designed and justified to the satisfaction of the code official. Only localized limit states related to interaction of the bracket and concrete foundations have been evaluated for this evaluation report. The effects of the reduced lateral sliding resistance due to uplift from wind or seismic loads must be considered for each project. Reference Table 1 for the allowable bracket capacity rating.

4.1.3 Shaft Capacity (P2): The top of the shafts must be braced, as prescribed in Section 1810.2.2 under the 2015, 2012 and 2009 IBC (Section 1808.2.5 for the 2006 IBC), and the supported structures such as concrete footings, are assumed to be adequately braced such that the supported structures provide lateral stability for the pile systems. In accordance with Section 1810.2.1 of the 2015, 2012 and 2009 IBC (Section 1808.2.9 for the 2006 IBC), any soil other than fluid soil must be deemed to afford sufficient lateral support to prevent buckling of the systems that are braced, and the unbraced length is defined as the length of piles standing in air, water, or in fluid soils plus an additional 5 feet (1524 mm) when embedment is into firm soil, or an additional 10 feet (3048 mm) when embedment is into soft soil. Firm soils are defined as soils with a Standard Penetration Test (SPT) blow count of five or greater. Soft soils are defined as soils with an SPT blow count greater than zero and less than five. Fluid soils are defined as soils with an SPT blow count of zero [weight of hammer (WOH) or weight of rods (WOR)]. Standard Penetration Test blow count must be determined in accordance with ASTM D1586. The shaft capacity of the helical foundation systems in air, water, or fluid soils must be determined by a registered design professional for support conditions, including effective unbraced lengths of shafts (those are not addressed in Table 3 of this report). The following are the allowable stress design (ASD) shaft capacities:

- Allowable compression capacity: Reference Table 3
- Allowable tension capacity: Reference Table 4
- Allowable lateral shear capacity: Reference Table 4
- Allowable bending capacity: Reference Table 4
- Torque rating: Reference Tables 1A and 1B

The elastic shortening/lengthening of the pile shaft will be controlled by the strength and section properties of the $2^7/_8$-inch-diameter (73 mm) shaft sections and the $2^3/_8$-inch-diameter (60 mm) coupler(s), as applicable. The elastic deflection of the piling will be limited to 0.00025 inch per lineal foot of shaft length per kips of axial load (0.00468 mm per lineal meter of shaft length per kN of axial load) plus 0.00025 inch per coupler per kips of axial load (0.00143 mm per coupler per kN of axial load). The slip in coupler is 0.207 in per coupler (5.3 mm per coupler). The mechanical properties of the shaft sections are shown in Tables 2 and can be used to calculate the anticipated settlements due to elastic shortening/lengthening of the pile shaft.

4.1.4 Helix Plate Capacity (P3): Up to three plates can be placed on a single helical pile. The helical plates are spaced in accordance with Section 3.2.2 of this report. For helical plates with more than one helix, the allowable helix capacity for the helical foundation system may be taken as the sum of the least allowable capacity of each individual helix. The helix allowable axial compression and tension capacities are listed in Table 5.

4.1.5 Soil Capacity (P4): The design axial compressive and tensile load capacities of helical piles based on soil resistance must be determined by a registered design professional in accordance with a site-specific geotechnical report, as described in Section 4.1.1, combined with the individual helix bearing method (Method 1), or from field loading tests conducted under the supervision of a registered design professional, as applicable (Method 2). For either Method 1 or Method 2, the predicted axial load capacities must be confirmed during the site-specific production installation, such that the allowable axial load capacities predicted by the torque correlation method must be equal to or greater than that predicted by Method 1 or 2, described above.

With the individual helix bearing method, the nominal axial load capacity of the helical pile is determined as the area of the helical bearing plate times the ultimate bearing capacity of the soil or rock bearing strata for the plate.

The design allowable axial load must be determined by dividing the ultimate axial load capacity predicted by either Method 1 or 2, above, by a safety factor of at least 2.

With the torque correlation method, the ultimate and allowable axial load capacities of the helical pile are predicted as follows:

$$Q_{ult} = K_t T \quad \text{(Eq. 1)}$$

$$Q_{all} = 0.5\, Q_{ult} \quad \text{(Eq. 2)}$$

where:

Q_{ult} = Ultimate axial tensile or compressive capacity (lbf or N) of the helical pile.

Q_{all} = Allowable axial tensile or compressive capacity (lbf or N) of the helical pile.

K_t = Torque correlation factor of 9 ft^{-1} (30 m^{-1}) in compression and tension for the $2^7/_8$-inch-outside-diameter (73 mm) round shaft.

T = Final installation torque in ft-lbf or N-m, which must not exceed the maximum installation torque prescribed in Tables 1A and 1B.

The maximum ultimate and maximum allowable axial compression and tension capacities predicted by the torque-correlation method are less than or equal to those axial verification test results. The smaller of the torque-correlation predicted maximum axial capacities (ultimate and allowable) and the axial verification test results are provided in Tables 1A and 1B, on soil capacities.

4.1.6 Helical Pile Foundation System: The overall allowable axial capacity of the Patriot Foundation Systems helical foundation system (in axial tension and axial compression) depends upon the analysis of interaction of brackets, shafts, helical plates and soils, and must be the lowest value of those for bracket capacity, shaft capacity, helical bearing plate capacity and allowable soil capacity. The overall allowable axial capacity must be limited to no more than 60 kips (266.9 kN), as required by Section 3.8 of AC358.

4.1.7 Foundation System (under the 2015, 2012 and 2009 IBC): Under the 2015, 2012 and 2009 IBC, the additional requirements noted in this section (Section 4.1.7) must be satisfied. For all design methods permitted under Section 4.1.1 of this report, the allowable axial compressive and tensile load of the helical pile system must be based on the least of the following conditions in accordance with 2015, 2012 and 2009 IBC Section 1810.3.3.1.9:

- P4: Allowable load predicted by the individual helix bearing method (or Method 1) described in Section 4.1.5 of this report.
- P4: Allowable load predicted by the torque correlation method described in Section 4.1.5 of this report.
- P4: Allowable load predicted by dividing the ultimate capacity determined from load tests (Method 2 described in Section 4.1.5) by a safety factor of at least 2.0. This allowable load will be determined by a registered design professional for each site-specific condition.
- P2: Allowable capacities of the shaft and shaft couplings. See Section 4.1.3 of this report.
- P3: Sum of the allowable axial capacity of helical bearing plates affixed to the pile shaft. See Section 4.1.4 of this report.
- P1: Allowable axial load capacity of the bracket. See Section 4.1.2 of this report.

4.2 Installation:

4.2.1 General: The helical pile systems must be installed in accordance with this section (Section 4.2), 2015, 2012 and 2009 IBC Section 1810.4.11, the site-specific approved construction documents (engineering plans and specifications), and the manufacturer's written installation instructions. In case of a conflict, the most stringent governs. The PFS helical foundation systems must be installed only by PFS trained and certified installers.

4.2.2 Pile Installation:

1. The helical piles must be located and installed in accordance with the site-specific approved construction documents.
2. The helical piles are installed with hydraulic rotary motors having forward and reverse capabilities.
3. A rotating head is attached to the pile top end using two high strength pins.
4. The pile shaft is screwed into the ground by applying a constant vertical downward force using the hydraulic equipment.
5. Helical piles must be installed vertically plumb into the ground with a ±1 degree of tolerance. The shaft maximum installation torque capacities are provided in Tables 1A and 2A, and cannot be exceeded during pile installation.
6. The helical piles must be installed clockwise in a continuous manner with the lead advancing at the helix pitch, with a rate of less than 25 revolutions per minute.

7. During installation the helical pile must be checked to ensure that the pile is vertically plumb with a ±1 degree of tolerance.
8. The gauge pressure or electronic torque indicator must be checked continuously to verify strength of the pile.
9. The gauge pressures or torque data and final depth must be recorded. The final torque reading is determined when the pile is "locked-in" or it can not proceed further.
10. The final depth must comply with the approved construction documents, if applicable, such as minimum depth required for frost protection.
11. Using the torque correlation formula described in this evaluation report, the allowable axial tension and compression capacities are estimated.
12. If required, extensions can be installed in order for the helix plate to reach a suitable soil-bearing stratum. Extensions must be selected based on approved plans as specified per the site conditions by a registered design professional. When the lead shaft is almost completely driven into the ground, an extension is aligned vertically over the lead shaft. The extensions and lead shafts must be connected together by two coupling bolts and matching nuts as described in Sections 3.2.3 and 3.3.6. Coupling bolts must be installed to a snug-tight condition as defined in Section J3 of AISC 360.
13. In order to avoid group effect for axial loading, the center-to-center spacing of helical piles must be at least three times the diameter of the largest helix plate at the depth of bearing.
14. In tension applications, the helical pile must be installed such that the minimum depth from the ground surface to the helix is 12D, where D is the diameter of the helix.
15. When the pile has reached the required depth, the rotary head is removed from the shaft, and the surrounding soils must be consolidated.
16. When the helical pile is installed to the required and appropriate depth as determined in accordance with the approved construction document by a registered design professional, the top of the last extension, which exceeds the elevation needed for fitting with the supported structure, may be cut to the appropriate elevation. Field cutting, and drilling if applicable, must be in accordance with the most restrictive requirements described IBC, AISC 360, and the manufacturer's written instructions
17. The side load or new construction bracket must be attached by the installer to the top of the shaft.
18. All field-cut or drilled pilings must be protected from corrosion as recommended by the registered design professional.

4.2.3 Bracket Installation:

- The support (repair or standard) bracket, utilized with the $2^7/_8$-inch-diameter (73mm) helical pile, must be installed as specified in the approved plans and specifications.
- The foundation must be excavated to create an "L" shaped cavity with a nominally 28-inch-wide (711 mm) opening and a nominal depth of 16 inches (406 mm) below the foundation bottom surface, to allow bracket access the foundation.
- The exposed foundation surfaces must be prepared to be flat and smooth to receive the bracket without obstruction on the bearing or facing surfaces.
- The helical pile foundation lead and shaft extensions must be installed into soil as set forth in Section 4.2.2.
- When the pile has been installed to the required depth, if the top of the extension is above the required elevation, excess shaft extension above the foundation may be cut as necessary so that connection to the bracket can take place.
- Connection of the bracket to the helical pile shall be in accordance with this evaluation report and the approved plans and must be designed by a registered design professional.
- Two connecting all-threaded rods, matching nuts and matching washers, as described in Sections 3.2.4 and 3.3.4, must be used to connect the bracket, T-bar and shaft (JW300 or PF300 series) together. Two additional bracket bolts and matching nuts, as described in Sections 3.2.4 and 3.3.4, must be installed on either side of the shaft to brace the side load bracket, and must be installed to a snug-tight condition as defined in Section J3 of AISC 360.
- When using the side load bracket, lifting of the structure must be verified by the registered design professional and the code official to ensure that the foundation and/or superstructure are not overstressed.
- For tensile applications, two bolts with matching nuts as described in Section 3.2.5 must be used to connect the new construction bracket to the top of the helical pile shaft. For compressive applications, the top of the helical pile shaft must be fully-bearing on the steel plate of the new construction bracket. The bolts must be installed snug-tight condition as defined in Section J3 of AISC 360.

4.3 Special Inspections:

Special inspection in accordance with Section 1705.9 of the 2015 and 2012 IBC (Section 1704.10 for the 2009 IBC, and Section 1704.9 for the 2006 IBC) must be performed continuously during the installation of the PFS helical foundation systems (piles and brackets). Where on-site cutting, bolting or welding is required, inspection in accordance with IBC Section 1705.2 of the 2015 and 2012 IBC (Section 1704.3 for the 2009 and 2006 IBC) is also required. Items to be recorded and confirmed by the special inspector include, but are not limited to, the following:

1. Verification of the product manufacturer and the manufacturer's certification of installers.
2. Product configuration and identification (including catalog numbers) for lead sections, extension sections, and brackets.
3. Installation equipment used.
4. Written installation procedures.
5. Threaded rods, bolts, nuts and washers as specified in the approved construction documents and this evaluation report.
6. Fielding cutting, bolting and welding as specified in the approved construction documents and this evaluation report.
7. Inclination and position of helical piles.

8. Tip elevations, installation torque and depth of helical piles.
9. Compliance of the installation with the approved construction documents and this evaluation report, including conditions and limitations described in the footnotes to the tables in this report.

5.0 CONDITIONS OF USE

The Patriot Foundation Systems helical foundation systems described in this report comply with, or are suitable alternatives to what is specified in, those codes noted in Section 1.0 of this report, subject to the following conditions:

5.1 The Patriot Foundation Systems helical foundation systems are manufactured, identified and installed in accordance with this report, the approved construction documents (engineering drawings and specifications), and the manufacturer's written installation instructions, which must be available at the jobsite at all times during installation. In case of a conflict, the most stringent requirement governs.

5.2 The Patriot Foundation Systems helical foundation systems have been evaluated for support of structures assigned to Seismic Design Categories A, B and C in accordance with IBC Section 1613. Helical foundation systems that support structures assigned to Seismic Design Category D, E or F, or that are located in Site Class E or F, are outside the scope of this report, and are subject to the approval of the code official based upon submission of a design in accordance with the code by a registered design professional.

5.3 All brackets must be used only to support structures that are laterally braced as defined in Section 1810.2.2 of the 2015, 2012 and 2009 IBC (Section 1808.2.5 for the 2006 IBC). Shaft couplings must be located within firm or soft soil as defined in Section 4.1.3.

5.4 The helical foundation systems must be limited to soil conditions that are not indicative of potential pile deterioration or corrosion situations, where conditions that are indicative of potential pile deterioration or corrosion situations are defined as the following: (1) soil resistivity less than 1,000 ohm-cm; (2) soil pH less than 5.5; (3) soils with high organic content; (4) soil sulfate concentrations greater than 1,000 ppm; (5) soils located in a landfill, or (6) soil containing mine waste.

5.5 Zinc-coated steel and bare steel components must not be combined in the same system. All helical foundation components must be galvanically isolated from concrete reinforcing steel, building structural steel, or any other metal building components.

5.6 The helical piles must be installed vertically into the ground with a maximum allowable angle of inclination of ±1 degree.

5.7 To comply with requirements found in Section 1810.3.1.3 of the 2015, 2012 and 2009 IBC (Section 1808.2.8.8 for the 2006 IBC), the superstructure must be designed to resist the effects of helical pile eccentricity.

5.8 Special inspection is provided in accordance with Section 4.3 of this report.

5.9 Engineering calculations and drawings, in accordance with recognized engineering principles as described in IBC Section 1604.4, and complying with Section 4.1 of this report, are prepared by a registered design professional and approved by the code official.

5.10 The adequacy of the supported structures that are connected to the brackets must be verified by a registered design professional in accordance with applicable code provisions, and subjected to the approval of the code official.

5.11 A geotechnical investigation report for each project site must be provided to the code official for approval in accordance with Section 4.1.1 of this report.

5.12 The load combinations prescribed in IBC Section 1605.3.1 or 1605.3.2 must be used to determine the applied loads. When using the alternative basic load combinations prescribed in IBC Section 1605.3.2, the allowable stress increases permitted by material chapters of the IBC or the referenced standards are prohibited.

5.13 For axial load, the minimum center-to-center spacing of helical piles must not be less than three times the diameter of largest helix plate at the depth of bearing. For piles with closer spacing, the pile allowable load reductions due to pile group effects must be included in the geotechnical report described in Section 4.1.1 of this report, and must be considered in the pile design by a registered design professional. Load reductions are subject to the approval of the code official.

5.14 In tension applications, the helical pile must be installed such that the minimum depth from the ground surface to the helix is 12D, where D is the diameter of the helix.

5.15 Settlement of helical piles is beyond the scope of this evaluation report and must be determined by a registered design professional as required in Section 1810.2.3 of the 2015, 2012 and 2009 IBC (Section 1808.2.12 of the 2006 IBC).

5.16 The applied loads must not exceed the allowable capacities described in Section 4.1 of this report.

5.17 Evaluation of compliance with Section 1810.3.11.1 of the 2015, 2012 and 2009 IBC (Section 1808.2.23.1.1 of the 2006 IBC) for buildings assigned to Seismic Design Category (SDC) C, and with IBC Section 1810.3.6 of the 2015, 2012 and 2009 IBC (Section 1808.2.7 of the 2006 IBC) for all buildings, is outside of the scope of this evaluation report. Such compliance must be addressed by a registered design professional for each site, and is subject to approval by the code official.

5.18 The Patriot Foundation Systems helical foundation systems are manufactured at the Hessen Xingsheng Auto Parts Industry Co. Ltd. facility located in Jiangsu, China, under a quality control program with inspections by ICC-ES. In addition, incoming helical pile products are verified for compliance with quality control requirements by Patriot Foundation Systems in San Antonio, Florida, under quality control program with inspections by ICC-ES.

6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Helical Pile Systems and Devices (AC358), dated October 2016.

7.0 IDENTIFICATION

Every helical pile and bracket assemblies of the Patriot Foundation Systems helical foundation systems described in this report is identified with a lot number, the report holder's name (Patriot Foundation Systems, LLC) and address, and the ICC-ES evaluation report number (ESR-3370).

TABLE 1—FOUNDATION STRENGTH RATING OF BRACKETS [4,5]

PRODUCT NUMBER	DESCRIPTION	SHAFT DIAMETER (inches)	MINIMUM CONCRETE STRENGTH (psi)	ALLOWABLE AXIAL COMPRESSION CAPACITY (kips)	ALLOWABLE AXIAL TENSILE CAPACITY (kips)
WA300	Side Load Bracket	2 $^{7}/_{8}$"	2500	23.44[1]	N/A
GB-08	New Construction Bracket	2 $^{7}/_{8}$"	2500	60.00[2]	23.29[3]

For **SI**: 1 inch = 25.4 mm, 1 kip (1000 lbf) = 4.48 kN.

[1]Load capacity is based on full scale load tests per AC358 with an installed 5'-0" unbraced pile length, based on 2015, 2012 and 2009 IBC Section 1810.2.1 (2006 IBC Section 1808.2.9.2), having a maximum of one coupling. Side load bracket must be concentrically loaded at the center of the bracket seat.
[2]The allowable compressive load capacity is based on the mechanical strength of the steel bracket, concrete punching shear capacity, and concrete bearing strength. The allowable load capacities have been determined assuming that minimum reinforcement has been provided as specified by ACI 318-14 Section 9.6.1.2 and ACI 318-11 Section 10.5.1. The minimum embedment of the bracket is 14.77 inches. The embedment depth is the distance between the top of the bracket plate to the top of the concrete footing. End of helical pile shaft must be fully bearing on bracket plate. The concrete footing must have a minimum width of 37.5 inches, and must be normal-weight concrete having a minimum compressive strength of 2,500 psi.
[3]The allowable tensile load capacity is based on the mechanical strength of the steel bracket, punching shear capacity and bearing to concrete footing. The allowable load capacities have been determined assuming that minimum reinforcement has been provided as specified by ACI 318-14 Section 9.6.1.2 and ACI 318-11 Section 10.5.1. The minimum embedment of the bracket is 8.97 inches. The embedment depth is the distance between the bottom of the bracket plate to the bottom of the concrete footing. The capacity is based using two ¾-inch through bolts as described in Section 3.2.5 of this report. The concrete footing must have a minimum width of 21.9 inches, and must be normal-weight concrete having a minimum compressive strength of 2,500 psi.
[4]The capacities are based on galvanized steel losing 0.013-inch (318 μm) steel thickness as indicated in Section 3.9 of AC358 for a 50-year service life.
[5]The capacities listed in Table 1 assume the structure is sidesway braced in accordance Section 4.1.3 of this report.

TABLE 1A—DESCRIPTION AND AXIAL SOIL CAPACITY OF 2.875-INCH PILE LEAD SECTIONS[(1,2)]

LOAD DIRECTION	PART NO.	LENGTH (feet)	HELIX OUTSIDE DIAMETER (inches)	K_t (ft^{-1})	MAX. INSTALLATION TORQUE (lb-ft)	MAX. ULTIMATE CAPACITY (kips)[3]	MAX. ALLOWABLE CAPACITY (kips)[3]
Compression and Tension	PF300-12-7	7	12	9	5859	52.7	26.4
	PF300-8/10-7		8 and 10				
	PF300-10/12-7		10 and 12				
	PF300-8/10/12-7		8, 10 and 12				

For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 kip = 4.448 kN, 1lbf-ft = 1.356 N-m, 1 ft^{-1} = 3.2808 m^{-1}.
[1]Refer to Figure 1 for shaft dimension designations.
[2]Refer to Section 4.1.5 for soil capacity, and Sections 4.1.6 and 4.1.7 for pile system capacity.
[3]The ultimate and allowable soil capacities (P4) listed in this table are the smaller of the torque-correlation predicted maximum axial capacities and the axial verification test results.

TABLE 1B—DESCRIPTION AND AXIAL SOIL CAPACITY OF 2.875-INCH PILE EXTENSIONS(1,2)

LOAD DIRECTION	PART NO.	LENGTH (feet)	K_t (ft^{-1})	MAX. INSTALLATION TORQUE (lb-ft)	MAX. ULTIMATE CAPACITY (kips)[3]	MAX. ALLOWABLE CAPACITY (kips)[3]
Compression and Tension	JW300-3	3	9	5859	52.7	26.4
	JW300-5	5				
	JW300-7	7				

For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 kip = 4.448 kN, 1lbf-ft = 1.356 N-m, 1 ft^{-1} = 3.2808 m^{-1}.
[1]Refer to Figure 2 for shaft dimension designations.
[2]Refer to Section 4.1.5 for soil capacity, and Sections 4.1.6 and 4.1.7 for pile system capacity.
[3]The ultimate and allowable soil capacities (P4) listed in this table are the smaller of the torque-correlation predicted maximum axial capacities and the axial verification test results.

TABLE 2—MECHANICAL PROPERTIES OF 2.875 INCH DIAMETER HELICAL SHAFT AND EXTENSION SECTIONS[1]

Mechanical Properties	After Corrosion Loss
Steel Yield Strength, F_y	55 ksi
Steel Ultimate Strength, F_u	75 ksi
Modulus of Elasticity, E	29,000 ksi
Nominal Wall Thickness	0.217 in
Design Wall Thickness	0.1956 in
Outside Diameter	2.8688 in
Inside Diameter	2.4782 in
Cross Sectional Area	1.64 in^2
Moment of Inertia, I	1.48 in^4
Radius of Gyration, r	0.95 in
Section Modulus, S	1.03 in^3
Plastic Section Modulus, Z	1.40 in^3

For **SI:** 1 inch = 25.4 mm, 1 ksi = 6.89 MPa, 1 ft-lb = 1.36 N-m, 1 lbf = 4.45 N.
[1]Dimensional properties are based on galvanized steel losing 0.013-inch steel thickness as indicated in Section 3.9 of AC358 for a 50 year service life.

TABLE 3—SHAFT ALLOWABLE COMPRESSION CAPACITY(1) (kips)

Shaft Effective Unbraced Length (KLu)[2,3,4](ft)		0	4	5	6	7	8	9	10	11	12	13	14	15
Shaft Capacities (kip)	No Coupler[5]	54.1	30.5	25.8	21.9	18.6	15.8	13.3	11.3	-	-	-	-	-
	1 Coupler[5]	36.7	9.6	8.9	8.3	7.6	7.0	6.4	5.8	5.3	4.9	4.5	4.1	3.8
	2 Couplers[5]	36.7	-	-	-	4.2	4.0	3.8	3.6	3.4	3.2	3.1	2.9	2.8

For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 kip = 4.448 kN.
[1]Capacities are based on galvanized steel losing 0.013-inch steel thickness as indicated in Section 3.9 of AC358 for a 50-year service life and presume the supported structure is braced in accordance with Section 1810.2.2 of the 2015, 2012 and 2009 IBC (Section 1808.2.5 of the 2006 IBC). Additionally, capacities account for bending stresses caused by a maximum inclination from vertical of 1 degree.
[2]Lu = total pile unbraced length in accordance with Section 1810.2.1 of the 2015, 2012 and 2009 IBC (Section 1808.2.9 of the 2006 IBC), including the length in air, water or in fluid soils, and the embedment length into firm or soft soil (non-fluid soil).
[3]K = effective length factor for shaft compression buckling consideration.
[4]KLu = Total effective unbraced length of the pile, where KLu = 0 represents a fully braced condition in that the total pile length is fully embedded in firm or soft soil and the supported structure is braced as noted in footnote 1, above.
[5]Total number of couplers within the total pile length.

TABLE 4—SHAFT ALLOWABLE CAPACITY (EXCEPT AXIAL COMPRESSION) [1,2]

HELICAL PILE SYSTEMS	COMPRESSION (kips)	TENSION (kips)	LATERAL SHEAR (kips)	BENDING MOMENT (kip-ft)	TORQUE RATING (lb-ft)
Single or Multi-helix leads and extensions	Table 3	23.7	10.5	2.3	Tables 1A and 1B

For **SI:** 1 inch = 25.4 mm, 1 kip = 4.448 kN, 1lbf-ft = 1.356 N-m, 1kip-ft = 1.356 kN-m.

[1]Capacities are based on galvanized steel losing 0.013-inch steel thickness as indicated in Section 3.9 of AC358 for a 50-year service life.

[2]Capacities are based on the lower capacity of the two components that are shaft and coupling.

TABLE 5—HELICAL PLATE ALLOWABLE CAPACITY FOR AXIAL TENSION AND AXIAL COMPRESSION [1]

PART NO.	HELICAL PLATE OUTSIDE DIAMETER (in.)	THICKNESS (in.)	ALLOWABLE CAPACITY (kips)
PF300-8	8	$^3/_8$	44.1
PF300-10	10		32.6
PF300-12	12		32.3

For **SI:** 1 inch = 25.4 mm, 1 kip = 4.448 kN.

[1]Capacities are based on galvanized steel losing 0.013-inch steel thickness as indicated in Section 3.9 of AC358 for a 50-year service life.

[2] See Section 4.1.4 of this report to address helix capacity of multi-helix configurations.

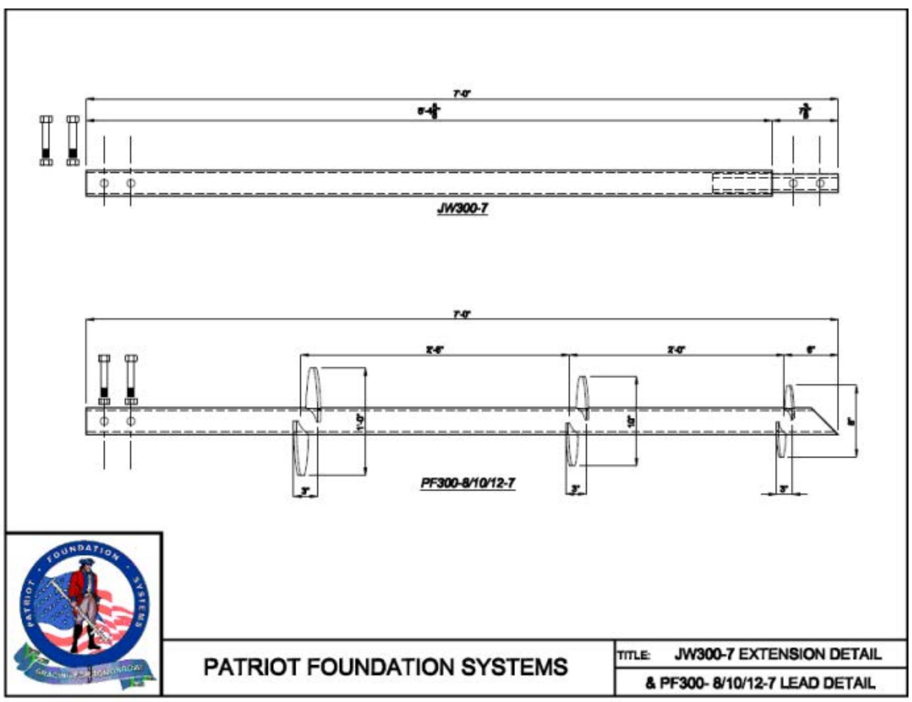

FIGURE 1—TYPICAL EXTENSION & LEAD DETAIL

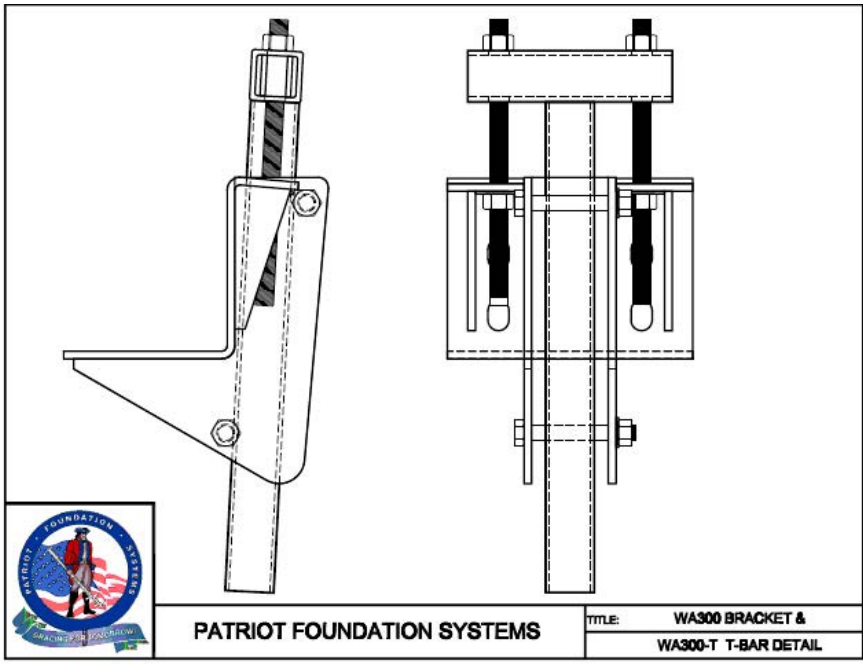

FIGURE 2—SIDE LOAD BRACKET

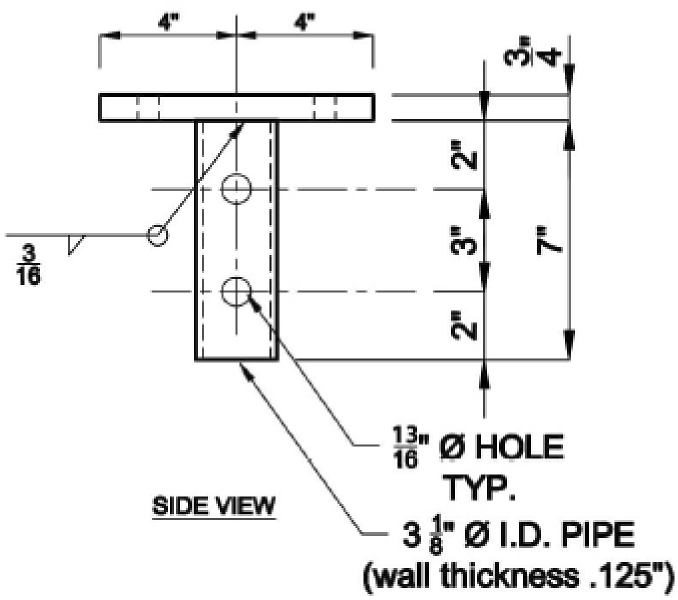

FIGURE 3—NEW CONSTRUCTION BRACKET

ICC-ES Evaluation Report

ESR-3370 FBC Supplement

Issued March 2017

This report is subject to renewal March 2018.

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DIVISION: 31 00 00—EARTHWORK
Section: 31 63 00—Bored Piles

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EVALUATION SUBJECT:

PATRIOT FOUNDATION SYSTEMS HELICAL FOUNDATION SYSTEMS

1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that the Patriot Foundation Systems Helical Pile Foundation Systems, recognized in ICC-ES master report ESR-3370, have also been evaluated for compliance with the code noted below.

Applicable code edition:

2014 *Florida Building Code—Building*

2.0 CONCLUSIONS

The Patriot Foundation Systems Helical Pile Foundation Systems, described in Sections 2.0 through 7.0 of the master evaluation report ESR-3370, comply with the 2014 *Florida Building Code—Building*, provided the design and installation are in accordance with the *International Building Code®* provisions noted in the master report and the following conditions apply:

- Design wind loads must be based on Section 1609 of the 2014 *Florida Building Code—Building*.
- Load combinations must be in accordance with Section 1605.2 or Section 1605.3 of the 2014 *Florida Building Code—Building*, as applicable.

Use of the Patriot Foundation Systems Helical Pile Foundation Systems for compliance with the High-Velocity Hurricane Zone provisions of the 2014 *Florida Building Code—Building* has not been evaluated, and is outside the scope of this evaluation report.

For products falling under Florida Rule 9N-3, verification that the report holder's quality assurance program is audited by a quality assurance entity approved by the Florida Building Commission for the type of inspections being conducted is the responsibility of an approved validation entity (or the code official when the report holder does not possess an approval by the Commission).

This supplement expires concurrently with the master report, issued March 2017.