ICC-ES Report

ESR-3750

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Issued 06/2016
This report is subject to renewal 06/2017.

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

REPORT HOLDER:

IDEAL MANUFACTURING, INC.

80 BLUFF DRIVE
EAST ROCHESTER, NEW YORK 14445

EVALUATION SUBJECT:

IDEAL HELICAL FOUNDATION SYSTEMS

ICC EVALUATION SERVICE
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ICC-ES Evaluation Report

ESR-3750

Issued June 2016
This report is subject to renewal June 2017.

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

REPORT HOLDER:

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EVALUATION SUBJECT:

IDEAL HELICAL FOUNDATION SYSTEMS

1.0 EVALUATION SCOPE

Compliance with the following codes:

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

Properties evaluated:

Structural and geotechnical

2.0 USES

Ideal 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 compression. tension and lateral loads from the supported structure to suitable soil bearing strata. Underpinning of existing foundations is generally achieved by attaching the helical piles to the repair brackets, which support compression loads. Deep foundations for new construction are generally obtained by attaching the helical piles to new construction brackets that are embedded in concrete pile caps, footings, or grade beams, which support compression, tension and lateral loads.

3.0 DESCRIPTION

3.1 GENERAL:

The Ideal Helical Foundation Systems consist of a helical pile lead section, extension sections, and a bracket that allows attachment to the foundation of the supported structure. The helical pile is screwed into the ground by applying torsion to a desired depth and suitable soil bearing strata. The bracket is then installed to connect the helical pile to the concrete foundation of the supported structure.

3.2 System Components:

3.2.1 Shafts: The lead sections consist of $2^7/_8$-inch-outside-diameter (73 mm) round steel tubing having a nominal wall thickness of 0.203 inch (5.15 mm) or 0.276 inch (7.01 mm). The helical plates, which are factory-welded to the lead shaft, allow advancement into the soil as the pile is rotated. The helical plates are 8, 10, 12 or 14-inch in diameter (203, 254, 305 or 356 mm), and are made from $^1/_2$-inch-thick (12.7 mm) steel plates. The helical plates are pressed to form a 3-inch (76 mm) pitch, and are then factory-welded to the helical lead shaft. The helical lead shafts come in a range between 2.5-foot-long (0.76 m) to 10-foot-long (3.05 m). Figure 4 illustrates a typical helical pile. The extension sections are similar to the lead sections, except that the extensions do not have helical plates. The extensions come in a range between 2.5-foot-long (0.76 m) and 11.5-foot-long (3.51 m). Extension sections have a factory-welded over-sized coupler, consisting of a 3½-inch-outside-diameter (89 mm) round steel tubing, at one end to fit over the lead shaft or other extension sections. Connection of extension sections to the lead shaft or other extension sections is made by through-bolted connections with two $^3/_4$-inch-diameter (19 mm) steel bolts through the extension coupler segment and the connected lead or other extensions. Figures 3 and 4 illustrate a typical extension and lead shaft. Leads and extensions are hot-dipped galvanized in accordance with ASTM A123.

3.2.2 Foundation Attachments (Brackets): Brackets are constructed from steel plate and round steel tubing components, which are factory-welded together. The different brackets are described in Sections 3.2.2.1 through 3.2.2. All brackets are hot-dipped galvanized in accordance with ASTM A123.

3.2.2.1 Repair Bracket (278CF): This bracket is used to support existing concrete foundations by transferring axial compressive loads from the existing foundations to the helical pile. The bracket is comprised of three components: seat, sleeve, and lifting T-bracket. The seat consists of ½-inch-thick top and bottom plates with ¼-inch-thick vertical steel stiffener plates. The plates are factory welded together to form the seat. The seat is then factory welded to a round $3^1/_2$-inch-outside-diameter (89 mm) steel tubing sleeve forming the bracket main body. A lifting T-bracket consists of factory welding ½-inch-thick (12 mm) plates, $^3/_8$-inch-thick (10 mm) plates, and round $2^1/_4$-inch-outside-diameter (57 mm) steel tubing. The lifting T-bracket is connected to the bracket main body with two $^7/_8$-inch-diameter steel threaded rods, four matching steel nuts, and matching steel washers. See Figures 1 of this report. The brackets are hot-dipped galvanized in accordance with ASTM A123.

3.2.2.2 New Construction Bracket: This bracket used with the helical pile system in new construction where the steel bearing plate of the bracket is cast into new concrete grade beams, footings, or pile caps. The bracket can transfer compression, tension, and lateral loads between the pile and the concrete foundation. The 278NCB8x34 bracket consists of an 8-by-8-by-$^3/_4$-inch-thick (203 by 203 by 19 mm) bearing plate. The bearing plate is factory welded to a round $3^1/_2$-inch-outside-diameter (89 mm) HSS sleeve with two predrilled $^{13}/_{16}$-inch (24 mm) through-holes. The bracket is attached to the shaft in the field with two ¾-inch (19 mm) standard hex bolts with matching ¾-inch (19 mm) standard hex nuts. See Figure 2 of this report. The brackets are hot-dipped galvanized in accordance with ASTM A123.

3.3 Material Specifications:

3.3.1 Helical Plates: The carbon steel plates conform to ASTM A572 Grade 50, and having a minimum yield strength of 50,000 psi (344 MPa) and a minimum tensile strength of 65,000 psi (448 MPa). The helical plates are factory-welded to the shafts, and are then hot-dipped galvanized in accordance with ASTM A123.

3.3.2 Helical Pile Lead Shafts and Extensions: The lead shafts and extensions are carbon steel round tubes that conform to ASTM A500, Grade C, except they have a minimum yield strength of 80,000 psi (551 MPa) and a minimum tensile strength of 90,000 psi (620 MPa). The lead shafts and extensions are hot-dipped galvanized in accordance with ASTM A123.

3.3.3 Extension Shaft Couplers: The extension shaft couplers are carbon steel round tubes that conform to ASTM A1026, except for having a minimum yield strength of 72,000 psi (496 MPa) and a minimum tensile strength of 79,000 psi (544 MPa). The extension shaft couplers are factory-welded to the extensions, and are then hot-dipped galvanized in accordance with ASTM A123.

3.3.4 Repair Bracket (278CF): The plates used to fabricate the repair bracket seat, stiffeners, and lifting T-bracket conform to ASTM A572 Grade 50, and having a minimum yield strength of 50,000 psi (345 MPa) and a minimum tensile strength of 65,000 psi (448 MPa). The lifting T-bracket stem and the sleeve of the seat are round steel tubing which conform to ASTM A500 Grade C, and having a minimum yield strength of 80,000 psi (551 MPa) and a minimum tensile strength of 90,000 psi (620 MPa). The repair bracket is hot-dipped galvanized in accordance with ASTM A123.

3.3.5 New Construction Bracket (278NCB8X34): The steel plate conforms to ASTM A572 Grade 50, and having a minimum yield strength of 50,000 psi (345 MPa) and a minimum tensile strength of 65,000 psi (448 MPa). The round steel tubing conforms to ASTM A1026, and having a minimum yield strength of 72,000 psi (496 MPa) and a tensile strength of 79,000 psi (544 MPa). The new construction bracket is galvanized in accordance with ASTM A123.

3.3.6 All Other Fastening Assemblies (Including Brackets): The threaded rods conform to ASTM A307 Grade A. The nuts conform to ASTM A563 Grade A and ASTM A194 Grade 2H. The washers conform to ASTM F844. Through-bolts used to connect the new construction bracket and shaft extensions and lead shafts conform to ASTM A325. Bolts, nuts, washers, and threaded rods are hot-dipped galvanized in accordance with ASTM A153.

4.0 DESIGN AND INSTALLATION

4.1 Design:

4.1.1 General: Engineering calculations and drawings, prepared by a registered design professional, must be submitted to the code official for each project, must be based on accepted engineering principles as described in IBC Section 1604.4, and must conform to 2015, 2012 and 2009 IBC Section 1810 (2006 IBC Section 1808). The load capacities shown in this report are based on allowable stress design (ASD) described in IBC Section 1602 and AISC 360 Section B3.4. 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 structural analysis must consider all applicable internal forces (axial, shear, bending moments, and torsional moments, if applicable) due to applied loads, load transfer between the bracket and the pile segments (leads and extensions), and maximum span(s) between helical foundations. The result of the analysis and the structural capacities must be used to select a helical foundation system. The minimum embedment depth for various loading conditions must be included, based on the most stringent requirements of the following: engineering analysis; tested conditions described in this report; a site-specific geotechnical investigation report; and site-specific load tests, if applicable.

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/or compression capacities of the helical piles, whatever is relevant for the project, and the expected total and differential foundation movements due to a single pile or pile group, as applicable.

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

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 soil profile.
4. Information on groundwater table, frost depth, and corrosion-related parameters, as described in Section 5.5 of this report.
5. Soil design parameters, such as: shear strength, soil allowable bearing pressure, unit weight of soil, soil deformation characteristics, and other parameters affecting pile support conditions as

defined in 2015, 2012 and 2009 IBC Section 1810.2.1 (2006 IBC Section 1808.2.9).

6. Confirmation of the suitability of helical foundation systems for the specific project.
7. Recommendations for design criteria, including, but not be limited to: mitigation of effects of differential settlement, 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 5.14 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.

The allowable axial compressive or tensile load of the helical pile system must be based on the least of the following in accordance with 2015, 2012 and 2009 IBC Section 1810.3.3.1.9:

- Sum of the areas of the helical bearing plates times the ultimate bearing capacity of the soil or rock comprising the bearing stratum divided by a safety factor of 2. This capacity will be determined by a registered design professional based on site-specific soil conditions.
- Allowable capacity determined from well-documented correlations with installation torque. Section 4.1.5 of this report includes torque correlation factors used to establish pile axial load capacities based on documented correlations.
- Allowable capacity predicted by dividing the ultimate capacity determined from load tests by a safety factor of at least 2.0. This capacity will be determined by a registered design professional for each site-specific condition.
- Allowable axial capacity of pile shaft. Section 4.1.3 of this report includes pile shaft capacities.
- Allowable axial capacity of pile shaft couplings. Section 4.1.3 of this report includes pile shaft coupling capacities.
- Sum of the allowable axial capacity of helical bearing plates affixed to pile. Section 4.1.4 of this report includes helical plate axial capacities.
- Allowable axial capacity of the bracket. Section 4.1.2 of this report includes bracket capacities.

4.1.2 Bracket Capacity: The concrete foundation must be designed and justified to the satisfaction of the code official with due consideration to the eccentricity of applied loads, including reactions provided by the brackets, acting on the concrete foundation. Only localized limit states of supporting concrete foundation, including punching shear and bearing, have been considered in this evaluation report. Other limit states are outside the scope of this evaluation report and must be determined by the registered design professional. The effects of reduced lateral sliding resistance due to uplift from wind or seismic loads must be considered for each project. Reference Table 2 for the allowable bracket capacity ratings.

4.1.3 Pile Shaft Capacity: The top of the shafts must be braced as described in 2015, 2012 and 2009 IBC Section 1810.2.2, and 2006 IBC Section 1808.2.5. In accordance with 2015, 2012 and 2009 IBC Section 1810.2.1, and 2006 IBC Section 1808.2.9, 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 must be defined as any soil with a Standard Penetration Test (SPT) blow count of five or greater. Soft soils must be defined as any soil with a SPT blow count greater than zero and less than five. Fluid soils must be defined as any soil with a SPT blow count of zero [weight of hammer (WHO) 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. The following are the allowable stress design (ASD) shaft capacities:

- Allowable compression capacity: Reference Tables 3A and 3B.
- Allowable tension capacity: 38,000 lbf (169 kN) for $2^7/_8$-inch-diameter helical piles with 0.203-inch wall thickness; 40,600 lbf (180.6 kN) for $2^7/_8$-inch-diameter helical piles with 0.276-inch wall thickness.
- Allowable bending moment: 5,270 lbf-ft (7.1 kN-m) for $2^7/_8$-inch-diameter helical piles with 0.203-inch wall thickness; 6,880 lbf-ft (9.3 kN-m) for $2^7/_8$-inch-diameter helical piles with 0.276-inch wall thickness.
- Allowable lateral shear: 16,200 lbf (72 kN) for $2^7/_8$-inch-diameter helical piles with 0.203-inch wall thickness; 21,500 lbf (95.6 kN) for $2^7/_8$-inch-diameter helical piles with 0.276-inch wall thickness.
- Torque Rating: 8,400 ft-lb (11.3 kN-m) for $2^7/_8$-inch-diameter helical piles with 0.203-inch wall thickness; 12,300 ft-lb (16.6 kN-m) for $2^7/_8$-inch-diameter helical piles with 0.276-inch wall thickness.

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) with 0.203-inch (5.15 mm) wall thickness or 0.276-inch (7.01 mm) wall thickness shaft sections and the shaft couplers, as applicable. The mechanical properties of the shaft section are shown in Table 1 and can be used to calculate the shortening of the pile shaft. The slip of the helical pile coupler is 0.256-inch (6.5 mm) at rated allowable compression/tensile load per coupling.

4.1.4 Helix Plate Capacity: The allowable axial compressive/tensile load capacities of the ½-inch-thick round shaped helical plates described in Section 3.2.3 of this report are the following:

- 8-inch diameter plate: 59,740 lbf (265 kN)
- 10-inch diameter plate: 49,280 lbf (219 kN)

- 12-inch diameter plate: 39,700 (176 kN)
- 14-inch diameter plate: 48,000 lbf (214 kN)

For helical piles with more than one helix, the allowable helix capacity for the helical foundation systems supporting axial compression and tension loads may be taken as the sum of the least allowable capacity of each individual helix. The helix plates are spaced three times the diameter of the lowest plate apart starting at the toe of the lead section.

4.1.5 Soil Capacity: The allowable axial compressive or tensile soils capacity of helical piles must be determined by a registered design professional in accordance with a site-specific geotechnical report, as described in Section 4.1, combined with the individual helix bearing method (Method 1), or from field loading tests conducted under the supervision of a registered design professional (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 axial load capacities predicted by the torque correlation method are equal to or greater than what is predicted by Method 1 or 2, described above. The individual bearing method is determined as the sum of the individual areas of the helical bearing plates times the ultimate bearing capacity of the soil or rock comprising the bearing stratum. The design allowable axial load must be determined by dividing the total ultimate axial load capacity predicted by either Method 1 or 2, above, divided by a safety factor of at least 2. The torque correlation method must be used to predict the ultimate capacity (Q_{ult}) of the pile and the minimum installation torque (Equation 1). A factor of safety of 2 must be applied to the ultimate capacity to determine the allowable soil capacity (Q_{all}) of the pile (Equation 2).

$Q_{ult} = K_t T$ *(Equation 1)*

$Q_{all} = 0.5\ Q_{ult}$ *(Equation 2)*

where:

K_t = Torque correlation factor of 9 ft^{-1} (29 m^{-1}) for axial compression load; or 7 ft^{-1} (26 m^{-1}) for axial tension load for $2^7/_8$-inch-diameter (73 mm) helical pile.

T = Final installation torque in ft-lbf or N-m. The final installation torque is defined as the last torque reading taken during the pile installation, using, for example, the torque reading instruments connected to the installation equipment.

The ultimate axial compression soil capacity of the $2^7/_8$-inch-diameter helical pile must not exceed 88,000 lbf (391 kN).

The allowable lateral soil capacity of the pile is referenced in Table 2 of this report is based on field testing of the $2^7/_8$-inch-diameter (73 mm) helical pile with a single 8-inch-diameter (203 mm) helix plate installed in a firm clay soil, having an average standard penetration test blow count of 20, at a minimum embedment of 15 feet (4.57 m). For soil conditions other than firm clay, the lateral capacity of the pile must be determined by a registered design professional.

4.2 Installation:

The Ideal Helical Foundation Systems must be installed by a certified and trained installers approved by Ideal Manufacturing Inc. The Ideal Helical Foundation Systems must be installed in accordance with this section (Section 4.2); 2015, 2012 and 2009 IBC Section 1810.4.11; the manufacturer's published installation instructions; and approved site-specific construction documents. In case of a conflict, the most stringent requirement governs.

4.2.1 Helical Pile Installation: The helical piles must be installed and located in accordance with the approved plans and specifications. The helical piles are typically installed using hydraulic rotary motors having forward and reverse capabilities, as recommended by Ideal Manufacturing, Inc. In conjunction with rotating the pile, an axial force (crowd sufficient to cause the pile to penetrate the earth at a rate of approximately 3 inches (76.2 mm) per revolution) is also applied. The installation speeds must be limited to less than 25 revolutions per minutes (rpm). The installation torque must not exceed 8,400 ft-lb (11.4 kN-m) for $2^7/_8$-inch-diameter helical piles with 0.203-inch wall, and 12,300 ft-lb (16.6 kN-m) for $2^7/_8$-inch-diameter helical piles with 0.276-inch wall thickness. Helical piles must be installed vertically into the ground with a maximum allowable angle of inclination of ±1 degree from vertical. The helical piles must be rotated clockwise in a continuous manner with the lead section advancing at the helix pitch. Extensions (number and length) are selected based on the approved plans as specified per the site conditions by a registered design professional. The extensions and the lead section must be connected by the use of two coupling bolts and nuts as described in Section 3.2.8. Coupling bolts must be snug-tightened as defined in Section J3 of AISC 360. The final installation torque must equal or exceed that specified by the torque correlation method, to support the allowable design loads of the structure. The helical piles must be installed to the minimum depth described in the approved plans, but with the helical plate not less than 5 feet (1.53 m) below the bottom of the supported concrete foundation. For tension application, the helical pile must be installed such that the minimum depth from the ground surface to the uppermost helix is 12D, where D is the diameter of the largest helix.

4.2.2 Foundation Attachments:

4.2.2.1 Repair Bracket: The repair bracket must be installed as specified in the approved plans. The repair bracket is installed by excavating the bottom of the footing or foundation and large enough to provide access for bracket installation. The excavation is extended under the footing for 14 inches (356 mm) from chiseled footing face, 12 inches (305 mm) below the footing, and 14 inches (356 mm) parallel with the footing. The face and underside of the footing for the bracket bearing plate is cleaned and chipped if highly irregular, and should be relatively flat. Existing concrete footing capacity must not be altered, such as with notching of concrete or cutting of reinforcing steel, without the approval of the registered design professional and the code official. The repair bracket is installed over the pile shaft, away from the concrete footing. The bracket is rotated into place under the footing and raised into position. The footing face and underside should be fully bearing on the bracket plate. Place non-shrink grout in any small voids between footing bracket plate and concrete footing. The pile shaft is cut off squarely at least 14 inches (356 mm) up from bottom of footing. This may change depending on the amount of lift. All field-cut or drilled pilings must be protected from corrosion as recommended by the registered design professional and approved by the code official. The T-bracket is installed over the pile shaft, and threaded rods, nuts and washers are added to hold the bracket in position. Coupling nuts, jacking bracket, and lifting jack are installed to raise the foundation to the desired elevation. Any lifting of the existing structure must be verified by a registered design professional and is subject to approval of the code official to ensure that the foundation, superstructure, and helical piles are not overstressed. The bracket can be lifted only after the grout has cured. Once the foundation has been raised to its desired elevation, the hex nuts over the T-bracket are tightened, and jacking brackets and lifting jacks are removed. The threaded-rod nuts must be snug-tightened as defined in Section J3 of AISC 360. The excavation must be backfilled in accordance with 2015, 2012 and 2009 IBC Section 1804 (2006 IBC Section 1803).

4.2.2.2 New Construction Bracket: New construction brackets must be placed over the top of the helical pile shaft. The top of pile elevation must be established and must be consistent with the specified elevation. If necessary, the top of the pile may be cut off level to the required length in accordance with the manufacturer's instructions and AISC 360 requirements so as to ensure full, direct contact (bearing) between the top of the pile shaft and the bracket. All field-cut or drilled pilings must be protected from corrosion as recommended by the registered design professional and approved by the code official. In the case of the New Construction Bracket 278NCB8x34, two ¾-inch-diameter (19 mm) bolts and matching nuts as described in Section 3.2.8 of this report must be installed. The bolts must be snug-tightened as defined in Section J3 of AISC 360. The embedment and edge distance of the bracket into the concrete foundation must be as described in the approved plans and as indicated in Table 2 of this report. The concrete foundation must be cast around the bracket in accordance with the approved construction documents.

4.3 Special Inspection:

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

1. Verification of product manufacturer and the manufacturer's certification of the installers.
2. Verification of product types and configurations for helical pile lead shaft sections, extensions, brackets, bolts, threaded rods, nuts, washers, and torque as specified in this report and the construction documents.
3. Installation procedures for helical pile shaft, installation equipment used, and the Ideal Helical Foundation Systems installation instructions.
4. Anticipated and actual piling depth.
5. Required target installation torque of piles and depth of the helical foundation system.
6. Inclination and position of helical piles; top of pile extension in full contact with bracket; tightness of all bolts; and evidence that the helical pile foundation systems are installed by an approved Ideal Helical Foundation Systems installer.
7. Other pertinent installation data as required by the registered professional in responsible charge and compliance of installation with the approved geotechnical report, construction documents, and this evaluation report.

5.0 CONDITIONS OF USE

The Ideal Helical Foundation Systems described in this report comply with, or are suitable alternatives to what is specified in, those codes indicated in Section 1.0 of this report, subject to the following conditions:

5.1 The helical pile system is manufactured, identified, and installed in accordance with this report, the approved construction documents, and the manufacturer's published installation instructions, which must be available at the jobsite at all times during installation. In the event of a conflict between this report, the approved construction documents and the manufacturer's published installation instructions, the most restrictive governs.

5.2 The helical pile system has been evaluated for support of structures assigned to Seismic Design Categories (SDCs) A, B and C in accordance with IBC Section 1613. Use of the systems to support structures assigned to SDC 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 building official, based upon submission of a design in accordance with the code by a registered design professional.

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

5.4 Installation of the helical foundation systems is limited to support of uncracked normal-weight concrete, as determined in accordance with the applicable code.

5.5 The helical foundation systems must not be used in conditions that are indicative of potential pile deterioration or corrosion situations, as defined by 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 landfill; or (6) soil containing mine waste.

5.6 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.

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

5.8 The helical piles must be installed vertically into the ground with a maximum allowable angle of inclination of 1 degree from vertical. To comply with the requirements found in 2015, 2012 and 2009 IBC Section 1810.3.1.3 (2006 IBC Section 1808.2.8.8), the superstructure must be designed to resist the effects of helical pile eccentricity.

5.9 A soil investigation (geotechnical report) in accordance with Section 4.1.1 of this report must be submitted to the code official for approval.

5.10 The load combinations prescribed in Section 1605.3.2 of the IBC must be used to determine the applied loads. When using the alternative basic load combinations prescribed in Section 1605.3.2, the allowable stress increases permitted by material chapters of the IBC (Chapters 19 through 23, as applicable) or the referenced standards are prohibited.

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

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

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

5.14 In order to avoid group efficiency effects, an analysis prepared by a registered design professional must be submitted where the center-to-center spacing of axially loaded helical piles is less than three times the diameter of the largest helix plate at the depth of bearing. An analysis prepared by a registered design professional must also be submitted where the center-to-center spacing of laterally loaded helical piles is less than eight times the least horizontal dimension of the pile shaft at the ground surface. For laterally loaded piles, spacing between helical plates must not be less than 3*D*, where *D* is the diameter of the largest helical plate measured from the edge of the helical plate to the edge of the helical plate of the adjacent helical pile; or 4*D*, where the spacing is measured from the center-to-center of the adjacent helical pile plates.

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

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

5.17 The Ideal Helical Foundation Systems are manufactured at the Ideal Manufacturing, Inc., facility located in Webster, New York, under a quality-control program with inspections by ICC-ES.

6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Helical Foundation Systems and Devices (AC358), dated June 2013(editorially revised September 2014).

7.0 IDENTIFICATION

The Ideal Helical F

oundation System components are identified by a tag or label bearing the name and address of Ideal Manufacturing Inc., the catalog number and the evaluation report number (ESR-3750).

TABLE 1—MECHANICAL PROPERTIES AFTER CORROSION LOSS[1] OF 2.875-INCH DIAMETER HELICAL SHAFT

Mechanical Properties	SHAFT DIAMETER	
	2.875-inch (0.203-inch wall thickness)	2.875-inch (0.276-inch wall thickness)
Steel Yield Strength, F_y (ksi)	80	80
Steel Ultimate Strength, F_u (ksi)	90	90
Modulus of Elasticity, E (ksi)	29,000	29,000
Nominal Wall Thickness (inch)	0.203	0.276
Design Wall Thickness (inch)	0.183	0.250
Outside Diameter (inch)	2.869	2.869
Inside Diameter (inch)	2.504	2.368
Cross Sectional Area (inch^2)	1.54	2.06
Moment of Inertia, I (inch^4)	1.40	1.78
Radius of Gyration, r (inch)	0.95	0.93
Section Modulus, S (inch^3)	0.97	1.24
Plastic Section Modulus, Z (inch^3)	1.32	1.72

For **SI:** 1 inch = 25.4 mm; 1 ksi = 6.89 MPa, 1 ft-lbf =1.36 N-m; 1 lbf =4.45 N.

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

TABLE 2—FOUNDATION STRENGTH RATINGS OF BRACKETS[5]

PRODUCT NUMBER	DESCRIPTION	SHAFT DIAMETER (inches)	ALLOWABLE CAPACITY (kips)		
			Compression	Tension	Lateral
278CF	Repair Bracket	$2^7/_8$	29.40[1]	N/A	N/A
278NCB8x34	New Construction Bracket	$2^7/_8$	86.42[2]	46.07[3]	0.997[4]

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 having a maximum of one coupling per 2015, 2012 and 2009 IBC Section 1810.2.1 and 2006 IBC 1808.2.9.2. Repair brackets must be concentrically loaded and the bracket plate must be fully engaged with bottom of concrete foundation. Only localized limit states such as mechanical strength of steel components and concrete bearing have been evaluated. Minimum specified compressive strength of concrete is 3,000 psi (20.68 MPa).
[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 16.07 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 40.1inches, 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 12.91 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 3.3.4 of this report. The concrete footing must have a minimum width of 29.8 inches, and must be normal-weight concrete having a minimum compressive strength of 2,500 psi.
[4]The allowable lateral capacity is based on limit states associated with mechanical steel strength, concrete breakout in accordance with ACI 318, and bracket bearing on unreinforced concrete in accordance with ACI 318. The bracket must be installed with a minimum embedment depth of 4 inches measured from the bottom of the bracket plate to the bottom of the concrete footing, and a minimum edge distance of 4 inches measured from the bracket plate edge to the concrete footing edge. The concrete footing must have a minimum width of 16 inches, and must be normal-weight concrete having a minimum compressive strength of 2,500 psi.
[5]The capacities listed in Table 2 assume the pile foundation system is sidesway braced per 2015, 2012 and 2009 IBC Section 1810.2.2 and 2006 IBC Section 1808.2.5.

N/A = not applicable.

TABLE 3A—ALLOWABLE COMPRESSION CAPACITY of $2^7/_8$–INCH-DIAMETER PILE (0.203-INCH WALL THICKNESS) WITH COUPLER ECCENTRICITY[3] (kips)

	Fully Braced (L_u = 0)	(Firm Soil) kL_u = 4 ft[1]	(Soft Soil) kL_u = 8 ft[1]
0 couplings (no eccentricity)	60.0	30.3	13.6
1 coupling[2]	48.3	24.9	12.4
2 coupling[2]	23.5	16.1	9.8

For **SI:** 1 inch = 25.4 mm; 1 ft = 0.305 m; 1 kip (1000 lbf) = 4.48 kN.

[1]L_u=Total unbraced pile length per 2015, 2012 and 2009 IBC Section 1810.2.1 and 2006 IBC Section 1808.2.9.2, including the length in air, water or in fluid soils, and the embedment length into firm or soft soil (non-fluid soil). kLu = total effective unbraced length of the pile, where kLu = 0 represent a fully braced condition in that the total pile length is fully embedded in firm or soft soil and the supported structure is braced in accordance 2015, 2012 and 2009 IBC Section 1810.2.2 (Section 1808.2.5 of the 2006 IBC).
[2]Number of couplings within L_u
[3]The capacities shown in Table 3A are for $2^7/_8$-inch-diameter (0.203-inch wall thickness) pilings installed with a maximum 1 degree of inclination and do not include an external guide sleeve. The capacities are also based on the assumption that the pile shaft is concentrically loaded.

TABLE 3B—ALLOWABLE COMPRESSION CAPACITY of $2^7/_8$–INCH-DIAMETER PILE (0.276-INCH WALL THICKNESS) WITH COUPLER ECCENTRICITY[3] (kips)

	Fully Braced (L_u = 0)	(Firm Soil) kL_u = 5 ft[1]	(Soft Soil) kL_u = 10 ft[1]
0 couplings (no eccentricity)	60.0	39.8	17.6
1 coupling[2]	60.0	33.6	16.2
2 coupling[2]	34.4	22.7	13.2

For **SI:** 1 inch = 25.4 mm; 1 ft = 0.305 m; 1 kip (1000 lbf) = 4.48 kN.

[1]L_u=Total unbraced pile length per 2015, 2012 and 2009 IBC Section 1810.2.1 and 2006 IBC Section 1808.2.9.2, including the length in air, water or in fluid soils, and the embedment length into firm or soft soil (non-fluid soil). kLu = total effective unbraced length of the pile, where kLu = 0 represent a fully braced condition in that the total pile length is fully embedded in firm or soft soil and the supported structure is braced in accordance 2015, 2012 and 2009 IBC Section 1810.2.2 (Section 1808.2.5 of the 2006 IBC).
[2]Number of couplings within L_u
[3]The capacities shown in Table 3B are for $2^7/_8$-inch-diameter (0.276-inch wall thickness) helical piles installed with a maximum 1 degree of inclination and do not include an external guide sleeve. The capacities are also based on the assumption that the pile shaft is concentrically loaded.

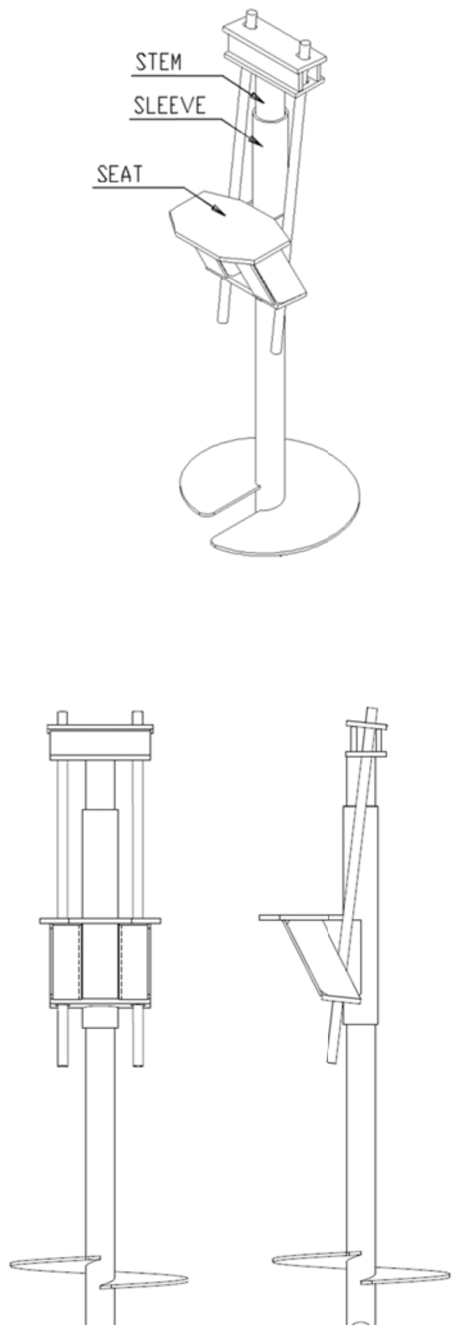

FIGURE 1—FOUNDATION REPAIR BRACKET

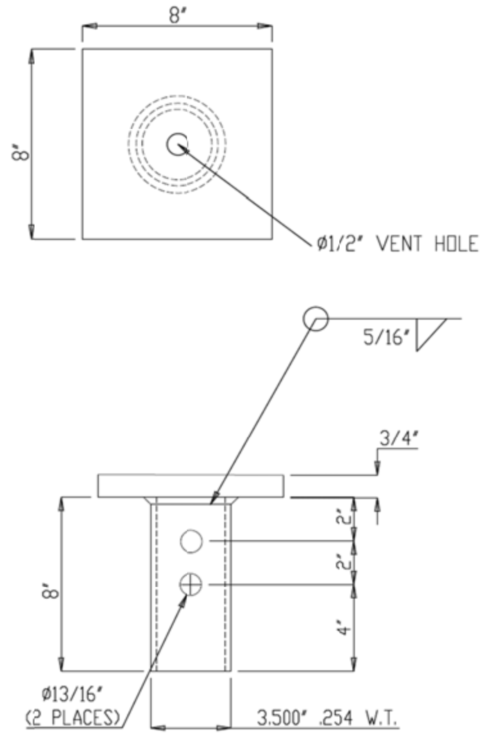

FIGURE 2—NEW CONSTRUCTION BRACKET

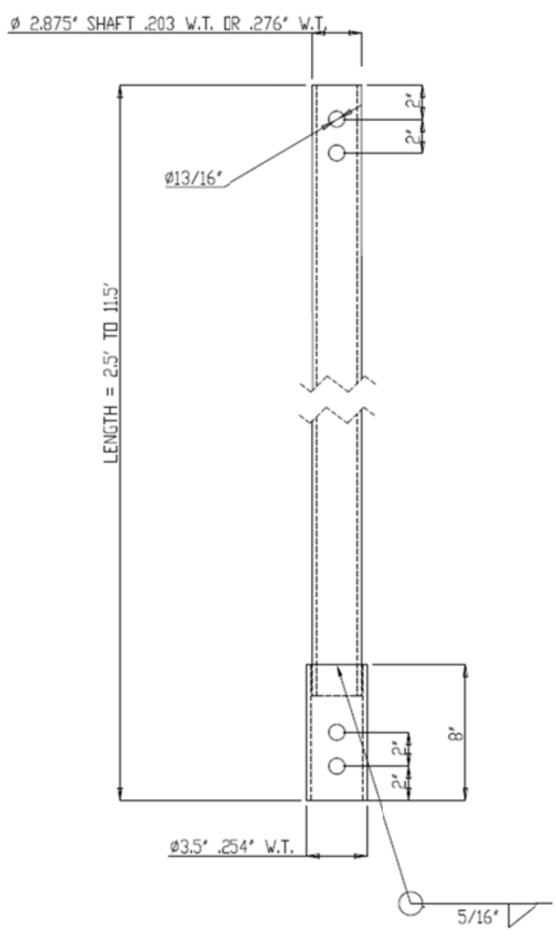

FIGURE 3—TYPICAL EXTENSION SECTION

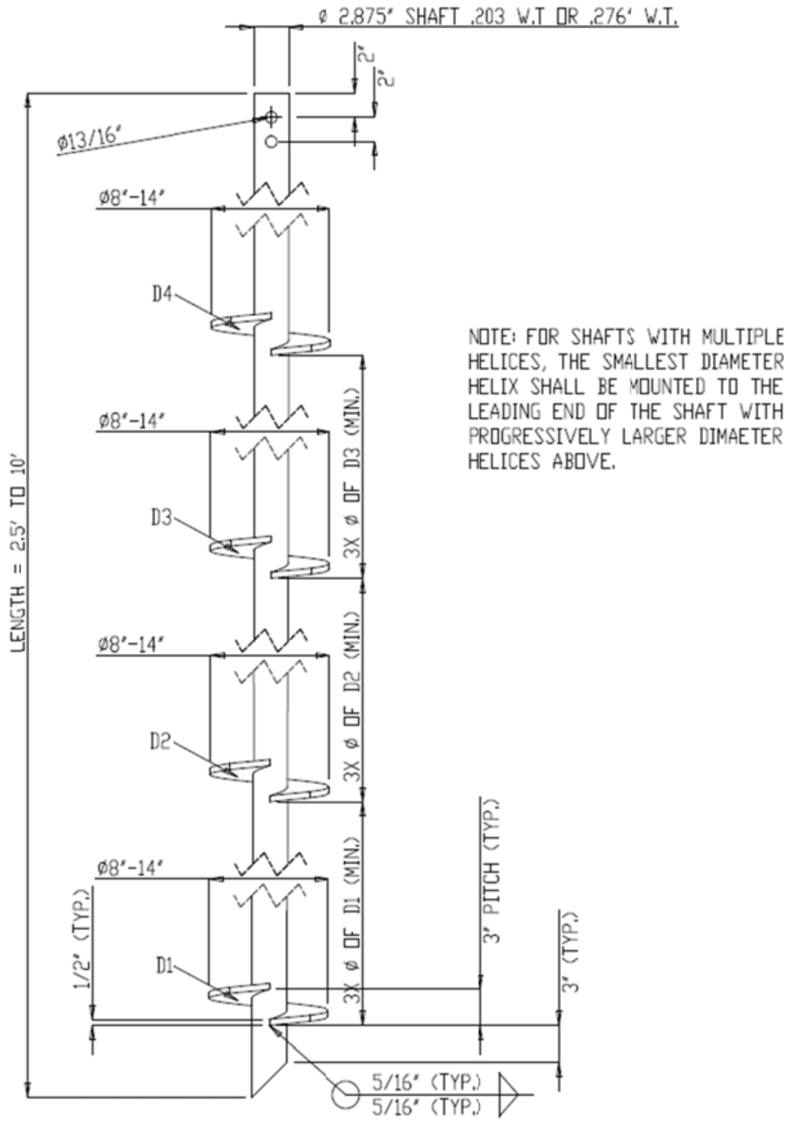

FIGURE 4—TYPICAL HELICAL LEAD SECTION AND HELICAL PLATES