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TECHNO METAL POST HELICAL FOUNDATIONS

CSI Section:

- 31 66 00 Special Foundations
- 31 66 15 Helical Foundation Piles

1.0 RECOGNITION

Techno Metal Post Helical Foundations manufactured by Techno-Pieux, Inc., have been evaluated for use as load-bearing foundation elements. The physical, structural, and durability characteristics and the manufacturing and installation methods of the helical foundations were evaluated. The helical foundations are recognized for use as alternatives to prescriptive foundations and footings for decks and other residential accessory structures, and for new construction and additions for residential occupancies built under the following codes:

- 2018, 2015, and 2012 International Residential Code® (IRC)

2.0 LIMITATIONS

Use of the Techno Metal Post Helical Foundations recognized in this report is subject to the following limitations:

2.1 Use of Techno Metal Post Helical Foundations shall comply with the provisions of the applicable codes, the manufacturer’s published installation instructions, and this report. Where conflicts occur in these provisions, the most restrictive shall govern.

2.2 Techno Metal Post Helical Foundations are for use in seismic design categories A, B, and C. Use of the helical foundations in seismic design categories D0, D1, D2, and E is outside the scope of this report.

2.3 Field welding shall be performed and verified in accordance with the provisions of the code.

2.4 The building official may require a soil test where the presence of questionable soil characteristics such as expansive, compressible, or shifting soils is likely, based on quantifiable data in accordance with IRC Section R401.4.

2.5 Allowable lateral load resistance capacities of the helical foundations have not been evaluated and shall be

determined by a registered design professional in a manner acceptable to the building official.

2.6 The capacity of the supported structure to transfer the design loads to the helical foundations is outside the scope of this report.

2.7 The Helical Foundations recognized in this report are produced by Techno-Pieux, Inc., in Thetford Mines, Quebec, Canada.

3.0 PRODUCT USE

3.1 Design: The design bearing capacity of the installed foundation shall be the lesser of, and shall not exceed, the helical foundation geotechnical bearing capacity (Section 3.1.1 of this report), the helical foundation structural capacity (Sections 3.1.2 and 3.1.3 of this report), and the capacity of the cap or bracket (Section 3.1.4 of this report) installed to transfer the load from the supported structure to the helical foundation. The Allowable Stress Design (ASD) method shall be used for design, considering all applicable limit states.

3.1.1 Helical foundation geotechnical capacity based on installation torque: The maximum axial geotechnical compression and tension capacities of the helical foundations shall be limited to the capacities established by applying the torque-to-capacity ratio and the applicable factors of safety to the final torque reached during installation in accordance with the allowable axial geotechnical capacity formula shown below. The model of helical foundation shall be selected so that the tabulated maximum allowable capacities are sufficient to support the design loads. An appropriate helical foundation assembly is selected based on load and expected soil resistance to achieve the required installation torque that will indicate adequate geotechnical bearing capacity has been reached. Installation shall be accomplished without exceeding the rated torque capacity, which was established by testing, to prevent damage to the assembly. The maximum rated torque correlates to the helical foundation maximum geotechnical axial capacities shown in Table 1 of this report.

The allowable geotechnical capacities for a helical foundation are determined using the following formula:

Allowable axial geotechnical capacity, $P_a = P_u / FS$
 where;

- P_u = Ultimate bearing capacity = $K_t \times T$ (lb)
- FS = Applicable factor of safety
- K_t = Torque-to-capacity ratio (ft^{-1})
- T = Torque applied during installation (lb-ft)

The product described in this Uniform Evaluation Service (UES) Report has been evaluated as an alternative material, design or method of construction in order to satisfy and comply with the intent of the provision of the code, as noted in this report, and for at least equivalence to that prescribed in the code in quality, strength, effectiveness, fire resistance, durability and safety, as applicable, in accordance with IBC Section 104.11. This document shall only be reproduced in its entirety.





To determine the allowable axial geotechnical capacity, the appropriate factor of safety for use in the allowable axial geotechnical capacity formula shall be chosen based on the type of structure to be supported, the availability of a soil report, and the direction of loading. For main structures in applications where a soil test is not available, a minimum safety factor of 2.5 shall be used to determine allowable geotechnical compression capacity. Where a soil test is available, and the soil is considered adequate, a minimum safety factor of 2.0 may be used. For residential decks, and freestanding accessory light-frame structures with an area of 600 square feet or less and an eave height of 10 feet or less, a safety factor of 2.0 may be used for compression determinations. For geotechnical tension capacity determination, a minimum safety factor of 2.5 shall be applied.

3.1.2 Support capacity based on column design: Portions of helical foundation shafts in fluid soils and portions not buried in the ground (both, unbraced conditions) shall be designed as columns using appropriate engineering standards in accordance with the AISC. Any soil other than fluid soil shall be sufficient lateral support to prevent buckling and allows the column to be designed as fully braced at a depth of 5 feet (1524 mm) in stiff soil, or 10 feet (3048 mm) in soft soil. Table 2 of this report shows Techno Metal Post Helical Foundation shaft structural axial compression capacity in soft or firm soils with laterally braced conditions at the top and with a maximum distance in air of 6 inches.

3.1.3 Capacity of helical foundations loaded in tension: Helical foundations may be used to resist design axial tension loads. The allowable axial tension capacity shall be determined based on installation torque and, when applicable, shall be limited to the weight of soil above the helix. In either case, the allowable capacity shall not exceed the structural tension capacity of the assembly given in Table 3 of this report.

Where the depth of the helix plate is at least twelve times the helix diameter (12D), the axial tension capacity may be based solely on the allowable axial geotechnical capacity formula in accordance with Section 3.1.1 of this report, using a safety factor of 2.5, minimum.

Where helical foundations are installed at depths less than 12D, shallow pull-out failure shall be avoided by further limiting the foundation tension capacity to the weight of the soil cone over the helix as depicted in Figure 3 of this report. The weight of a soil cone based on density and saturation is given in Table 5 of this report assuming an angle of 30 degrees.

3.1.4 Helical foundations limited by cap or bracket capacity: Helical foundations shall be limited to the capacity of the cap or bracket connected to the top of the helical foundation shaft and supporting the load from the structure. The appropriate cap or bracket for the support

situation shall be chosen to transfer the load from the structure into the helical foundation. Underpinning bracket allowable capacity shall be limited to the values in Table 4 of this report.

3.1.5 Corrosion: The likely effects of corrosion shall be considered, and adequate sacrificial material shall be provided to maintain helical foundation support capacity for a 50-year projected service life. The helical foundation shaft shall not lose more than 33 percent of its required design base metal thickness during the service life of the helical foundation.

3.1.6 Helical foundation lateral load capacity: Any lateral load resistance capacity of helical foundations, where required, shall be determined by a registered design professional in a manner acceptable to the building official.

3.1.7 Capacity of helical foundations based on field testing: When use of helical foundations falls outside the limitations of this evaluation report, or when capacities are in doubt, field testing may be used to determine the capacity of the helical foundation systems. Where field tests are required to confirm the capacity of a helical foundation installation, these tests shall be supervised by a registered design professional.

3.2 Installation: The helical foundations shall be installed by personnel trained and approved by the helical foundation system manufacturer using manufacturer-approved equipment specially designed to drive the helical foundations into the ground using measurable downward and rotational pressure. The equipment shall be calibrated yearly or as necessary to validate the relationship between hydraulic pressure and installation torque. The installer's certification and the equipment certificate of calibration shall be presented to the building official upon request.

In the absence of data indicating the presence of questionable soils, and unless the building official determines that a soil test is required, the helical foundations shall be installed in undisturbed soil or engineered fill using the helical foundations torque-to-capacity ratio and appropriate factors of safety to determine their geotechnical capacities. The torque applied to a helical foundation during installation shall never exceed the maximum rated torque in accordance with Table 1 of this report. Helical foundation installation shall continue until the appropriate installation torque is reached, indicating that the helical foundation has achieved the desired bearing capacity. Installation shall also continue until bearing plates reach below frost line, and to a minimum depth not less than 4 feet (1219 mm) for helical foundations loaded in compression. For helical foundations loaded in tension, the depth shall be sufficient to avoid a shallow pull-out failure as determined by design.

The spacing between helical foundations (center to center of pile shaft) shall be minimum 3 times the diameter of the largest helix in adjacent helical foundations. The foundation



shaft shall be within 0.35 degrees of vertical (or 1/2 inch in 7 feet) when installation is complete. Adequate drainage shall be provided directing water away from the foundation support locations. Where helical foundations are installed on or adjacent to slopes, the negative effects of drainage, erosion, and shallow failures shall be avoided in accordance with IRC Section R403.1.7.

3.2.1 Extensions: For the P2 and P3 helical foundations, extensions shall be added as necessary to reach the desired depth of bearing strata. Extensions for the P1 helical foundations are outside the scope of this evaluation. The extensions shall be field welded in accordance with AWS 1.1, using a continuous weld around the shafts at the joints between the extension couplers and the helical foundation shafts being extended (see Figure 1). The welds shall be 3/16-inch (4.76 mm) fillet welds for the P2 and 1/4-inch (6.35 mm) fillet welds for the P3 helical piles. The torque applied to install each extended helical foundation provides an effective proof test with a built-in safety factor for these field-welded extensions, up to the installed geotechnical capacity of the helical foundation.

3.2.2 Caps or brackets: Once adequate depth and bearing capacity is reached, the shaft shall be cut-off and an appropriate cap or bracket shall be installed to transfer the supported load to the helical foundation. The cap or bracket shall be adequately anchored to the top of the helical foundation using bolts, welds, screws, or otherwise attached to the shaft and to the supported structure above so that the helical foundation is concentrically axially loaded in accordance with design. Alternatively, for remedial foundation work, an underpinning bracket (Figure 2 and Table 4 of this report) may be used that imposes an eccentric load on the helical foundations in accordance with design.

3.2.3 Field reports: A helical foundation installation log shall be prepared describing the installation results and safe geotechnical capacities shall be determined from this data acquired during installation. Installers shall record all foundation locations and types including shaft diameters, helix sizes, embedment depths, heights of the top of the piles, and final torque readings. In addition, a torque profile shall be recorded for every job, and at least one out of every ten piles in multi-pile installations.

A field report containing this information, along with the type of project, relevant details of the supported structure, sketch or drawing of the support situation with dimensions, the types of helical foundation caps or brackets used and the connection of these to the helical foundation and the supported structure, allowable geotechnical capacity based on torque-to-capacity ratio and other relevant notes and comments as needed, shall be reviewed and sealed by a registered design professional. The report shall be submitted to the building official for approval within 10 days after helical foundation installation.

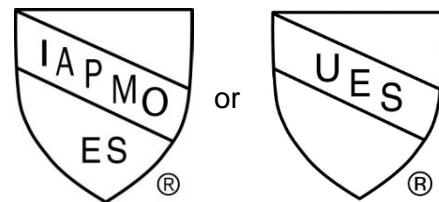
4.0 PRODUCT DESCRIPTION

Techno Metal Post Helical Foundations are foundation elements consisting of steel shafts on which are welded helical bearing plates. Shaft extensions, joined by couplers, are used to allow the bearing plates to reach deeper bearing strata where necessary. The shafts and extensions for Techno Metal Post Helical Foundations are made from ASTM A500 Grade C steel pipes having yield strength of 51 ksi (352 MPa) minimum, in pipe diameters and thicknesses shown in Table 1. The helical bearing plates (helix) are made from ASTM A36 steel plate material having yield strength of 44 ksi and tensile strength of 65 ksi (303 MPa and 448 MPa), minimum, 3/8-inch-thick (9.53 mm) for the P1 and P2 helical foundations, and 1/2-inch-thick (12.7 mm) for the P3 helical foundations. The plates are bent to a standard pitch of 3 in. The plates are factory welded to the helical foundation shafts in accordance with the manufacturer's quality control system. The assemblies may be bare steel or hot-dip galvanized in accordance with design.

The tops of the foundations have caps or brackets to transfer the supported load to the helical foundations. An adjustable bracket is available to provide a shelf to support existing structures for remedial foundation work. The bracket is welded or otherwise connected to the pile shaft and loads the pile eccentrically. The caps and brackets are made from ASTM A36 steel having yield strength of 44 ksi and tensile strength of 65 ksi (303 MPa and 448 MPa), minimum, and connection of the caps and brackets to the shafts shall be done in accordance with engineered design using accepted engineering standards and practices.

5.0 IDENTIFICATION

Techno Metal Post Helical Foundations are identified by the Techno-Pieux, Inc. name and trademark, model name, and evaluation report number (ER-481). The identification also includes the IAPMO Uniform Evaluation Service Mark of Conformity. Either Mark of Conformity may be used as shown below:



IAPMO UES ER-481



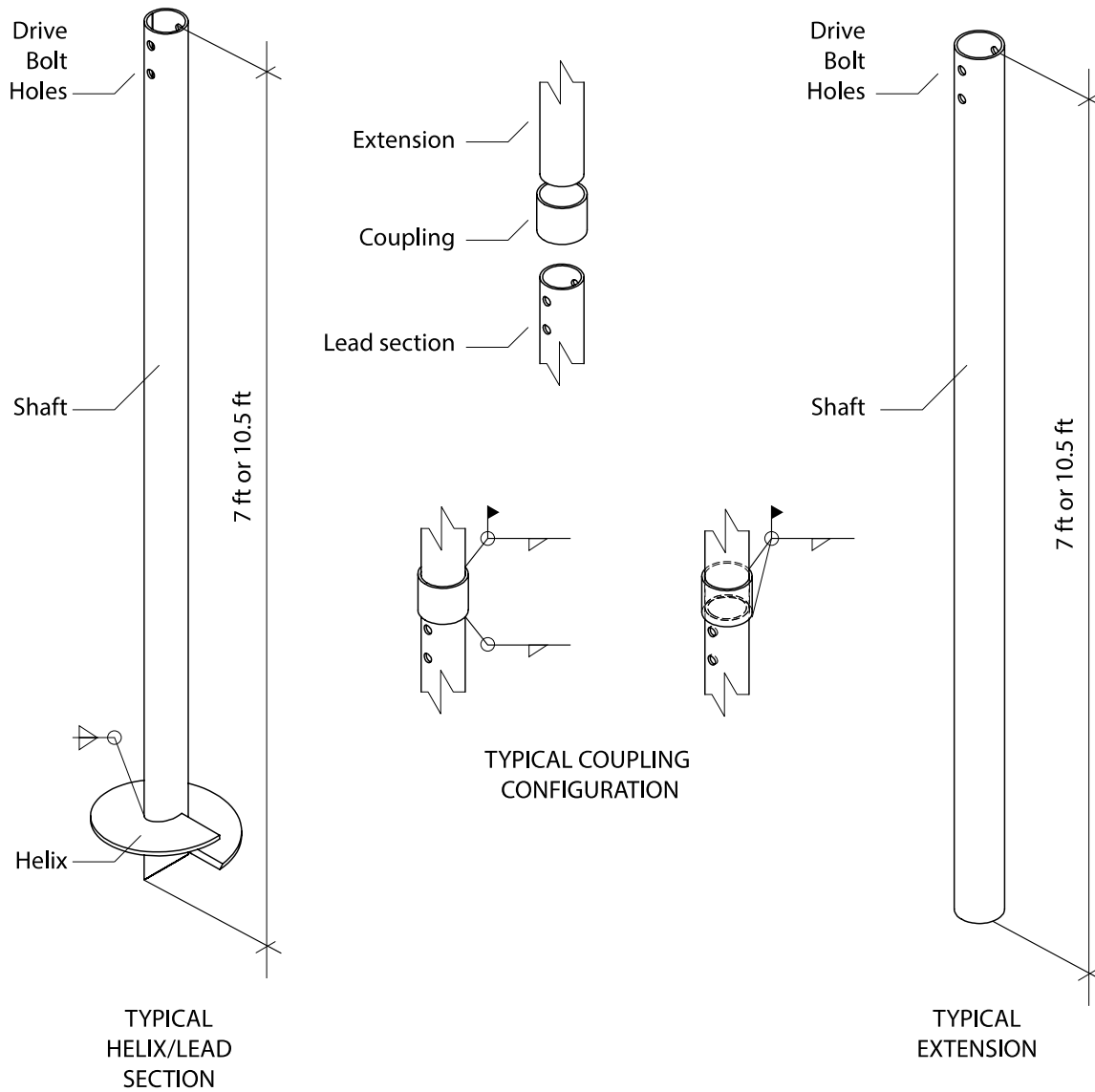
6.0 SUBSTANTIATING DATA

- 6.1 Documentation in accordance with IAPMO-UES Evaluation Criteria for Helical Foundations for Use under the IRC, EC 027-2019.
- 6.2 Reports of field testing to establish Torque-to-Capacity Ratio for each helical foundation model.
- 6.3 Test reports are from laboratories in compliance with ISO/IEC 17025.

7.0 STATEMENT OF RECOGNITION

This evaluation report describes the results of research completed by IAPMO Uniform Evaluation Service on Techno Metal Post Helical Foundations to assess their conformance to the codes shown in Section 1.0 of this report and documents the product's certification. The Techno Metal Post Helical Foundations are produced at locations noted in Section 2.7 of this report under a quality control program with periodic inspection under the supervision of IAPMO UES.

For additional information about this evaluation report please visit www.uniform-es.org or email at info@uniform-es.org



[Figure 1 - Basic Helical Assembly]



TABLE 1 – HELICAL FOUNDATION DIMENSIONS AND GEOTECHNICAL CAPACITIES BY MODEL NUMBER

Model ¹	Helix Diameter (in)	Shaft Outer Diameter (in)	Nominal Shaft Thickness (in)	Maximum Rated Torque (ft-lbf)	Torque-to-capacity Ratio (K _t)	Maximum Allowable Axial GEOTECHNICAL Capacity (lbf) ²		
						SF=2	SF=2.5	SF=3
P1-6	6	1 7/8	0.145	1,336	10	6,679	5,344	4,453
P1-8	8							
P1-10	10							
P1-12	12							
P2-8	8	2 3/8	0.154	2,242	10	11,210	8,968	7,473
P2-10	10							
P2-12	12							
P2-16	16							
P3-8	8	3 1/2	0.216	8,509	7	29,782	23,825	19,854
P3-10	10							
P3-12	12							

S.I.: 1 inch = 25.4 mm; 1 ft-lbf = 1.4 N-m; 1 lbf = 4.4 N

- Helical foundations are available in bare steel or hot-dip galvanized steel.
- The maximum allowable axial geotechnical capacities were determined by testing to establish the maximum torque rating and the torque-to-capacity ratio coefficient, K_t. The allowable capacities include a safety factor (SF) as shown.
- Allowable axial tension loading shall consider the possible shallow pull-out failure. Twelve times the helix diameter (12D) shall be sufficient to develop the tension capacities tabulated. Depths less than 12D shall consider and be limited to the weight of soil above the helix.

TABLE 2 – HELICAL FOUNDATION STRUCTURAL COMPRESSION CAPACITY BY MODEL NUMBER

Helical Foundation Structural Allowable Compression Capacity (lbf) ^{1,3,5}					
Firm Soils ^{2,4}			Soft Soils ^{2,4}		
P1	P2	P3	P1	P2	P3
6,900	11,600	32,200	3,000	5,900	22,300

S.I.: 1 lbf = 4.4 N

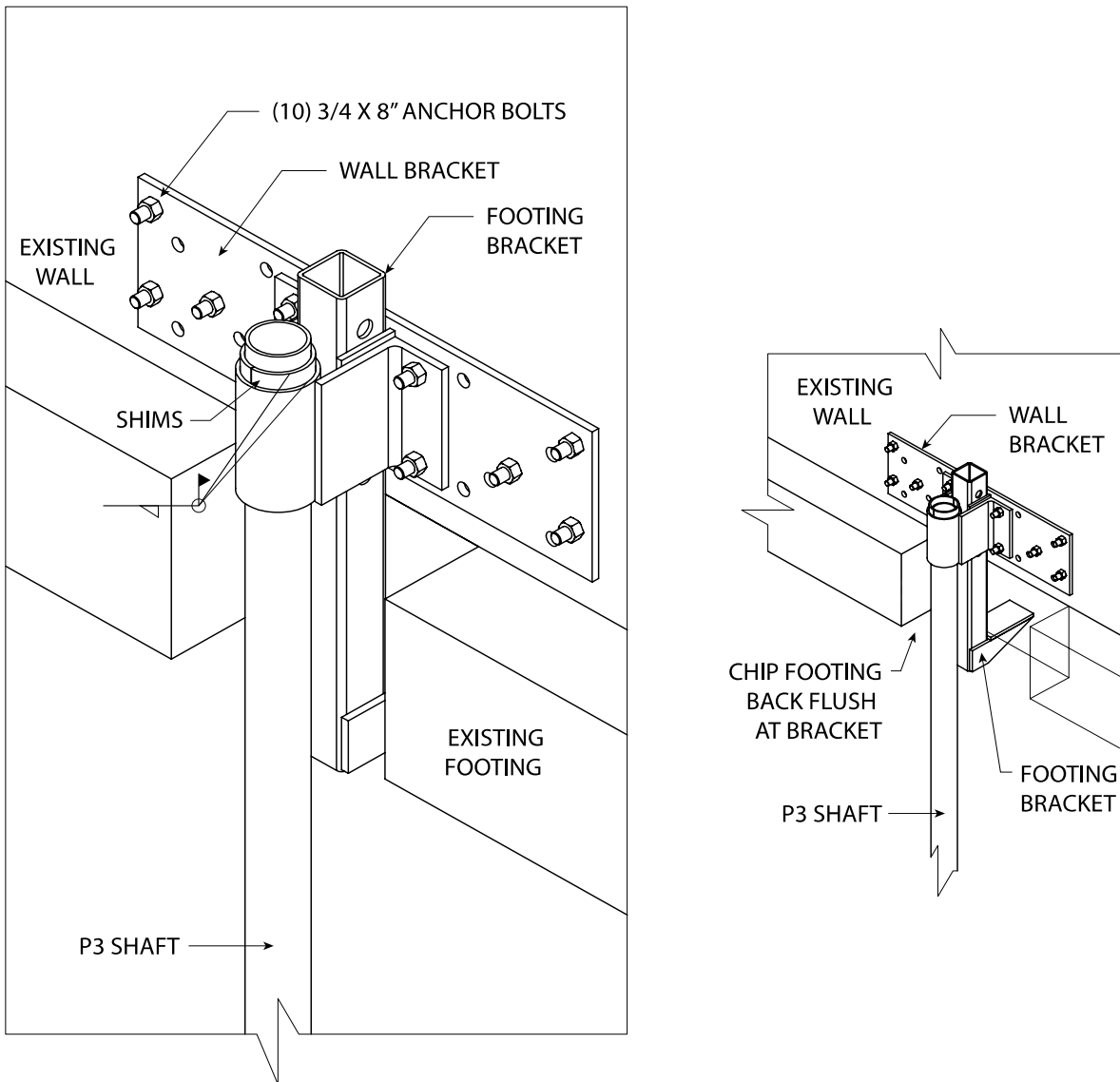
- Geotechnical capacity (i.e. installation torque) may control.
- Firm soils are defined as any soils defined in IRC Table 401.4.1 with N=4 or greater. Soft soils are defined as soil with bearing capacity less than Table 401.4.1 and with 1<N<4. Any site with helical foundations that span distances in air (more than 6 inches) or have fluid soils require site specific engineering review.
- Assumes shafts are pinned at the top (i.e. braced 2 ways) and fixed at depth of 5 ft or 10 ft depth for firm and soft soil respectively.
- Assumes eccentricity 0.5 inches plus shaft miss alignment of 0.35 degrees.
- Capacities include allowance for corrosion for 50-year design life. Sites with high corrosive potential require site specific engineering review.

TABLE 3 – HELICAL FOUNDATION STRUCTURAL TENSION CAPACITY BY MODEL NUMBER

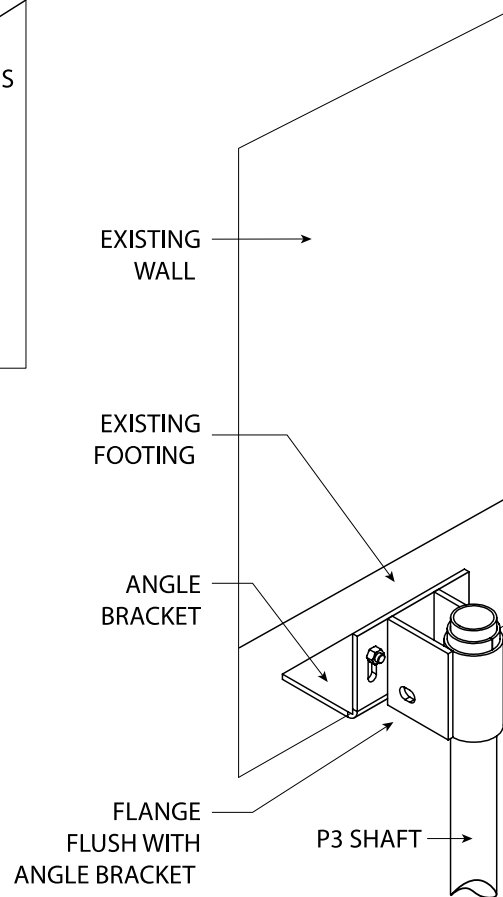
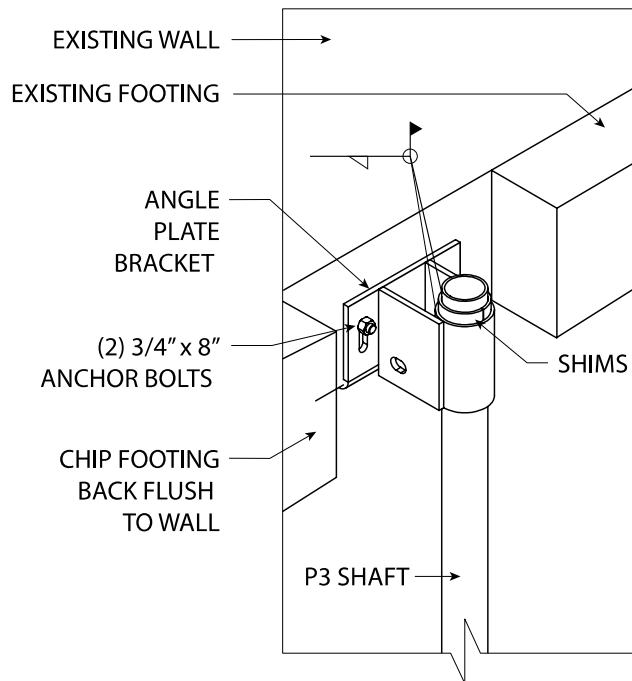
Helical Foundation Shaft Allowable Tension Capacity (lbf) ^{1,4}		
P1 ³	P2 ²	P3 ²
16,300	10,400	23,800

S.I.: 1 lbf = 4.4 N

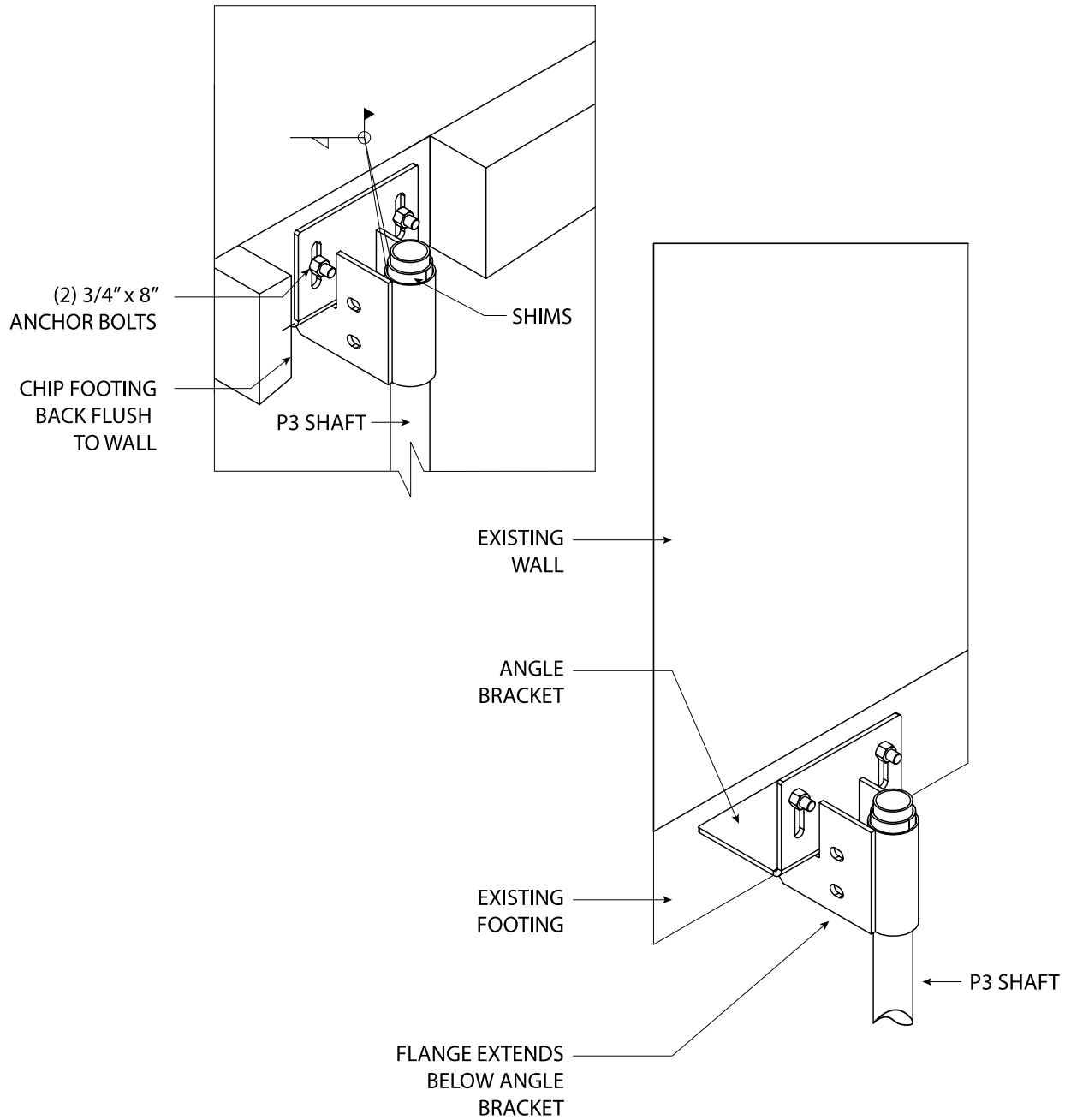
- Geotechnical capacity (i.e., installation torque) may control.
- Coupling strength controls.
- No Coupling included in analysis
- Capacities include allowance for corrosion for 50-year design life. Sites with high corrosive potential require site specific engineering review.



[Figure 2A - SM1 underpinning bracket]



[Figure 2B - SM3 underpinning bracket]



[Figure 2C - SM4 underpinning bracket]



TABLE 4 – HELICAL FOUNDATION UNDERPINNING BRACKET CAPACITY

Underpinning Bracket Allowable Structural Capacity	
Bracket Type	Allowable Load (lbf) ^{1,2}
SM-3	16,000
SM-4	20,800
SM-1	29,500

S.I.: 1 lbf = 4.4 N

1. Bracket shall be bolted to concrete foundation in accordance with the manufacturer's instructions. Capacities based on minimum $f'_c=2500$ psi concrete compressive strength. Evaluation of foundation to span between brackets is outside the scope of this report.
2. Capacities based on helical foundation shafts fully imbedded in firm soils.

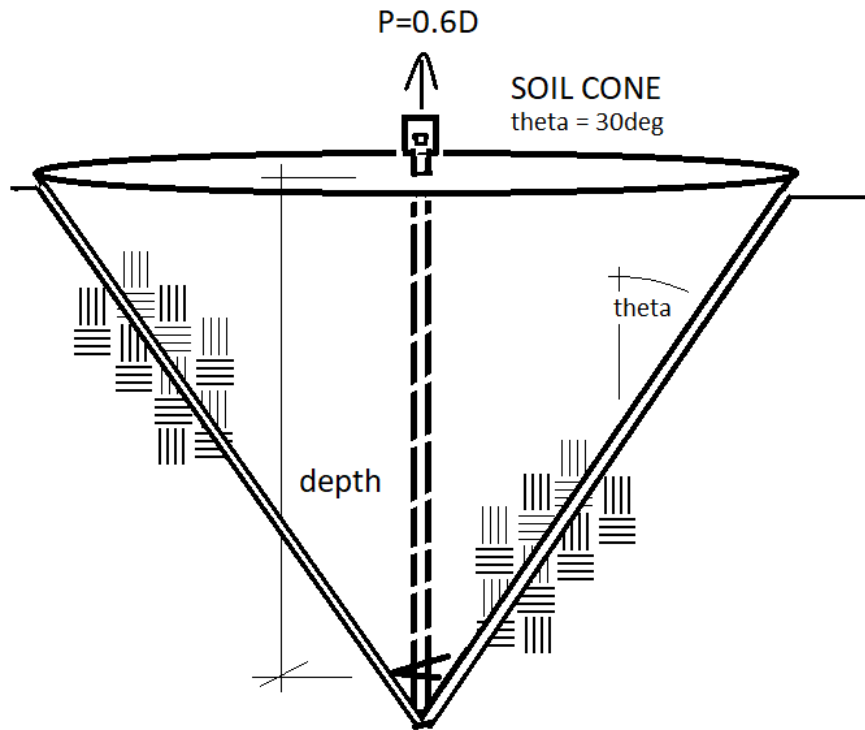
TABLE 5 – SHALLOW FOUNDATION PULL-OUT RESISTANCE (ALLOWABLE UPLIFT RESISTANCE) FOR INFLUENCE CONE HAVING A THETA ANGLE OF 30 DEGREES

Max Allowable Uplift Capacity for Shallow Helix Embedment Depth (<12D) (lbs)							
Helix Depth (ft)	Cone Volume (ft ³)	Soil Dry Unit Weight (pcf)			Soil Submerged Unit Weight (pcf)		
		90	110	125	56	69	78
4	22.3	1,200	1,500	1,700	800	900	1,000
5	43.6	2,400	2,900	3,300	1,500	1,800	2,000
6	75.4	4,100	5,000	5,700	2,500	3,100	3,500
7	119.7	6,500	7,900	9,000	4,000	4,900	5,600
8	178.6	9,600	11,800	13,400	6,000	7,300	8,300
9	254.3	13,700	16,800	19,100	8,600	10,500	11,900
10	348.9	18,800	23,000	-	11,700	14,300	16,300
11	464.4	-	-	-	15,600	19,100	21,700

S.I.: 1 inch = 25.4 mm; 1 ft = 305 mm; 1 lbf = 4.4 N

Notes:

1. This table is based on the weight of soil above the shallowest helix as depicted in Figure 3. The allowable capacity shall not exceed the structural tension capacity of the assembly given in Table 3 of this report.
2. The allowable hold down force is independent of the helix diameter and is based on load combination 0.6 x weight of soil.
3. Tabulated values may be interpolated for soil densities between those given. The values do not apply to very loose or saturated soils with lesser densities than those tabulated.
4. The shape of the influence cone is defined by an angle, theta, conservatively assumed to be maximum 30 degrees from vertical rather than the more commonly used angle of 45 degrees.
5. Submerged unit weight shall be assumed (water table at grade elevation) unless determined to be otherwise by site specific investigation.
6. Weight of soil shall be reduced to account for overlapping influence cones where multiple helical foundations are used in tension side-by-side when spacing between foundations is less than the depth of the helix.



[Figure 3 - Soil Cone used for Shallow Pull-Out Resistance]