INSTALLATION METHODOLOGY
Section 6

CONTENTS

SYMBOLS USED IN THIS SECTION
(In order of appearance)

DL	Dead Load	6-1
LL	Live Load	6-1
FS	Factor of Safety	6-1
SPT	Standard Penetration Test	6-2
N	SPT Blow Count	6-2
N_q	Bearing Capacity Factor	6-2
GWT	Ground Water Table	6-2
PL	Proof Load	6-3
Q_{ult}	Ultimate Uplift Capacity	6-5
K_t	Empirical Torque Factor	6-5
T	Average Installation Torque	6-5
SS	Square Shaft	6-5
RS	Round Shaft	6-5
H_d/S_d	Helix to Shaft Diameter Ratio	6-6
Q_{act}	Actual Capacity	6-9
Q_{calc}	Calculated Capacity	6-9
Q_{act}/Q_{calc}	Capacity Ratio	6-9
CID	Cubic Inch Displacement	6-12

DISCLAIMER

The information in this manual is provided as a guide to assist you with your design and in writing your own specifications. Installation conditions, including soil and structure conditions, vary widely from location to location and from point to point on a site.

Independent engineering analysis and consulting state and local building codes and authorities should be conducted prior to any installation to ascertain and verify compliance to relevant rules, regulations and requirements.

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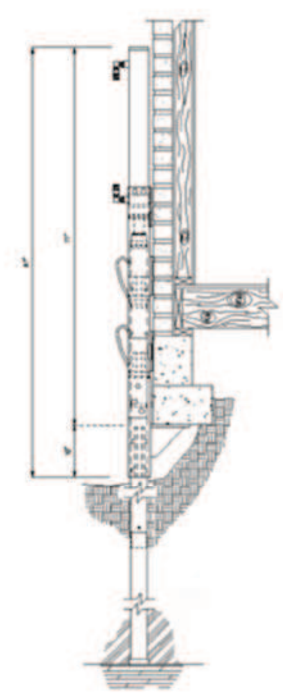
ATLAS RESISTANCE® PIERS

Atlas Resistance® Piers develop their capacity as a result of a pile tip or end bearing reaction in soil or rock that is achieved by hydraulically driving hollow pier sections to suitable strata utilizing the reaction weight of an existing structure or any other mass or reaction assembly capable of resisting pushing loads in excess of design loads required. The friction reduction collar on the initial or starter section allows for an end bearing pile. Most Atlas Resistance® Piers are installed to a force equal to a minimum of 150% of the calculated total load at each pier placement. The total load condition is a sum of the structure Dead Loads (DL) and all known potential Live Loads (LL). In addition to the usual calculated loads, it is extremely important to include loads imposed from soil overburden over a projected area, primarily outside of the foundation wall footprint (toe or heel) of the footing. The area of the projection plus the height of soils above it produce a loading condition that is quite often in excess of the structure load itself. When lifting the structure is desired, an additional "soil wedge" area and/or volume should be considered relative to the soil type and its particular characteristics. To be conservative in design calculations it is prudent to consider the long term loading effect from soils outside of the vertical and horizontal plane of the soil overburden even when stabilization only is desired.



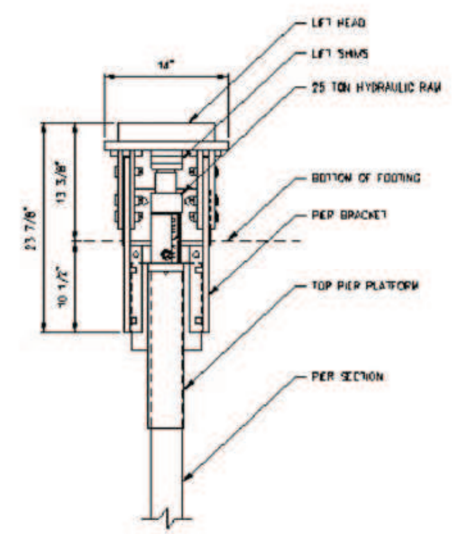
Installation Configuration
Figure 6-1

LOAD VERIFICATION

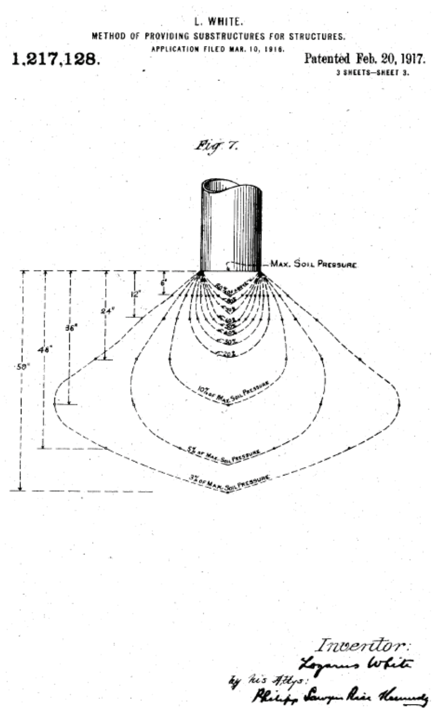
Atlas Resistance® Piers are installed using hydraulic cylinders with known effective areas. Although larger cylinders are available for extreme load conditions, the standard installation cylinders have an effective area of 8.29 in^2. The effective area of the cylinder is multiplied by the hydraulic pressure monitored by a gauge mounted between the hydraulic pump and the cylinder. The net result of this number is the actual force (in lbs) achieved as the pier sections are driven against the reaction weight of the structure until the required load is achieved or structure lift occurs. Additional pier sections are added as necessary until a competent bearing stratum is reached. The force is logged at the end of each pier section driven on the field installation log.

TWO STAGE SYSTEM METHODOLOGY

The installation of Atlas Resistance® Piers incorporates a two stage method that consists of driving each pier individually using the reaction from adjacent line loads. The integrity of the foundation determines the extent to which additional Factors of Safety (FS) can be achieved between the installation force and final lift loads. *Figure 6*-1 provides a schematic drawing that illustrates the installation of pier sections. The second stage occurs when all or the majority of the piers are loaded simultaneously using a manifold or series of manifolds and hydraulic rams placed at each pier. The manifolds and rams are connected to a pump or series of pumps depending on the number of piers being lifted. During the lifting stage the hydraulic pressure is monitored on each manifold system gauge. Typical 25 ton lifting rams have an effective area of 5.15 in^2. The load at each pier is monitored at the final lock off and noted on the field installation logs. The actual lift or lock off load at each pier can then be compared to the installation loads at each pier to determine the actual Factor of Safety developed between installation loads and actual loads required to produce structural lift and support. *Figure 6-2* provides a schematic drawing illustrating the lift stage.



Restoration Using Lift Head
and Hydraulic Ram
Figure 6-2



Assumed Stress Bulb Under Pile Tip
Figure 6-3

BEARING CAPACITY

The compressive bearing capacity of Atlas Resistance® Piers is developed by end-bearing due to the friction reduction collar at the lead end of the initial or starter section. Friction calculations do not normally enter into design steps unless required to comply with some older municipal codes. Increased tip areas (larger diameter pipe) will typically increase load resistance during installation of the pile. Standard pier section diameters are 2-7/8”, 3-1/2”, and 4-1/2”. The selection of pier size is determined through consideration of pile load requirement, column stability (buckling concerns) structure integrity and the ability to drive the pile past seasonal zones of influence relative to available reaction forces. Bracket assemblies are coupled with the appropriate pier section size to service both the geotechnical and structural requirements.

CLAY SOILS

In clay soil conditions defined as very stiff to hard, i.e., Standard Penetration Test (SPT) "N" values in excess of 35-40 blows/foot, it has been shown empirically that an Atlas Resistance® Pier can generate substantial end-bearing capacity, often in excess of 50,000-60,000 lbs of bearing resistance. While the high capacities defy absolute calculation for both very dense sand and hard clay, empirical data developed over the last several decades gives evidence to this phenomenon. Data developed by A.S. Vesic (1972) for the Transportation Research Board suggests that hard/dense soil develops very high capacities due to the formation of a larger pile bulb at the base of an end-bearing foundation. This phenomenon results in higher values for the bearing capacity factor (Nq), especially for driven piles. *Figure 6-3* is an excerpt from Patent 1.217.128 issued to L. White. It is a graphical rendition of the assumed large stress bulb formed under a pile tip.

SAND SOILS

Atlas Resistance® Piers also develop substantial end-bearing capacities in granular soils, but the sand or gravel must typically exhibit a high relative density with "N" values in excess of 30-35 blows/ft. The same pile bulb described above for clay soils will form at the base of an Atlas Resistance® Pier in sand soils. In granular soils, the overburden pressure (effective vertical confining stress) has a large influence on bearing capacity, so the deeper the pier tip is embedded, the higher the bearing capacity will be for a given sand deposit of uniform density. A design condition consisting of a shallow ground water table (GWT) will require Atlas Resistance® Piers to be installed to a sufficient depth to counteract the reduction in confining stress caused by the buoyancy effect of the water.

BEDROCK BEARING SURFACE

The presence of an intact bedrock surface represents an ideal ground condition for a totally end-bearing load transfer for any type of foundation. In this case the Atlas Resistance® Pier is installed to the rigid bearing surface represented by the bedrock layer, with load confirmation being verified by monitoring of the hydraulic pressure and effective area of the installation cylinder. The design capacity in this case is directly related to the structural strength of the pier shaft and bracket assembly.

INSTALLATION OVERVIEW

When the loading, structure and geotechnical conditions have been determined, the proper pier brackets and pier sections can be selected. Following excavation for the installation, the footing (if present) is notched to a point flush with the wall to be underpinned. Should steel reinforcement be encountered, notify the Engineer of Record prior to cutting. This procedure is performed to minimize the eccentricity of the pier assembly. In situations where notching the footing is prohibited, consideration needs to be given to the published pier capacity ratings if the footing extension from the wall is excessive, possibly increasing the eccentric load on the pier assembly resulting in a lower capacity. The bottom of the footing should be prepped and/or a load bearing grout added between the pier bracket and footing to provide a uniform bearing connection. This is a critical point, especially in high load conditions. Failure to comply with this step could result in a point load on the bracket and cause an early bracket failure.

When the bracket and installation equipment are properly positioned and anchored to the foundation or wall, the starter section can be placed in a vertical and plumb position. Activate the hydraulic pump to advance and retract the installation cylinder as necessary to drive the pier sections (see photo at top right). The pressure is recorded at the end of each 42" pier section. Continue driving pier sections until reaching strata capable of resisting the estimated Proof Load (PL) or until structure lift occurs. When approaching the end of the drive, a good rule of thumb is to drive pipe until either the structure begins to lift and/or the pressure continues to build. If a small amount of movement has occurred but the pressure remains constant, an experienced installer will continue to drive pipe until either a more significant movement is noted or a consistent build in pressure occurs. Depending on the integrity of the foundation and the comfort level of the installer, this will often result in substantial Factors of Safety in excess of 1.5. When driving the pier pipe is completed, the installation equipment is removed, pier sections are cut off to an appropriate elevation relative to the bracket type and load transfer components are set in place.

When all piers have been installed, the manifolds and hydraulics are loaded uniformly as much as possible (see photo at bottom right). Upon transfer of load to the entire pier assembly, lift pressures are noted at each pier and recorded on the field log. The ***actual verified Factor of Safety*** between installation pre-load and final lock off can then be confirmed. *Table 6-1* is an example of the driving (installation) and lift forces that could be involved in the installation of Atlas Resistance® Piers.

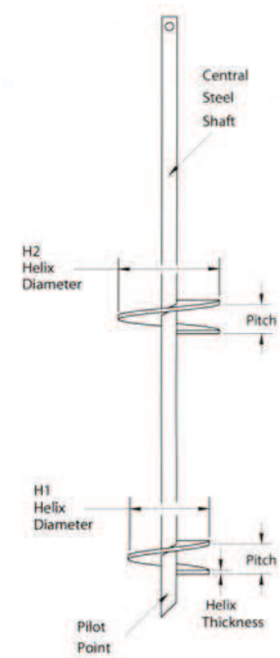
Refer to the *Atlas Resistance® Standard, Heavy Duty and Modified 2-Piece Pier Systems Model Specification in Appendix C* of this Technical Design Manual for detailed installation instructions.

Installation Load vs Lift Load
Table 6-1

FIRST STAGE – INSTALLATION LOAD SUMMARY	STD. DRIVE CYLINDER EFFECTIVE AREA (SQ. IN) 8.29		DRIVE ← / LIFT →	SECOND STAGE – PIER LIFT/LOCK SUMMARY	STD LIFT RAM EFFECTIVE AREA (SQ. IN) 5.15		F/S DRIVE vs LIFT
PIER NUMBER	PSI	LOAD		PIER NUMBER	PSI	LOAD	
1	4,200	34,818		1	4,000	20,600	1.7
2	4,600	38,134		2	4,000	20,600	1.9
3	4,600	38,134		3	4,500	23,175	1.6
4	4,800	39,792		4	4,500	23,175	1.7
5	5,000	41,450		5	4,800	24,720	1.7

CHANCE® HELICAL ANCHORS/PILES

By definition, a helical anchor/pile is a low soil displacement foundation element specifically designed to minimize disturbance during installation. In their simplest forms, helical anchors/piles consist of at least one helix plate and a central steel shaft (*see Figure 6-4*). The helix geometry is very important in that it provides the downward force or thrust that pulls a helical anchor/pile into the ground. The helix must be a true ramped spiral with a uniform pitch to maximize efficiency during installation. If the helix is not formed properly, it will disturb the soil rather than slice through it at a rate of one pitch per revolution. The central steel shaft transmits the driving energy or torque from the machine to the helix plate(s). The shaft should have a slender size and shape in order to reduce friction during installation. A helical anchor/pile functions very similar to a wood screw except that it has a discontinuous thread-form and is made to a much larger scale.



Helical Anchor/pile
Figure 6-4