

DIAMOND PIER®

**INSTALLATION
MANUAL**

2011

Pin Foundations, Inc.
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Bldg # E - 60
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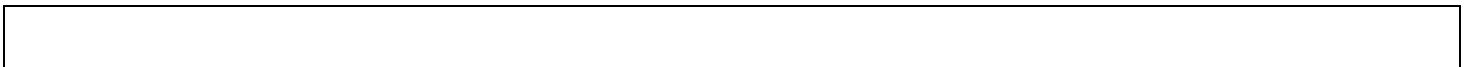
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Reference: DP-50 Evaluation Services Report, ESR-1895

This installation document is also available on the Pin Foundations website, www.diamondpiers.com, or call (612) 309-2640.



Diamond Pier[®] with Pin Pile Technology

Foundation Engineering

At Pin Foundations Inc. we've been engineering foundations for over 25 years, and one thing has always driven our thinking - *the soil is the true support* - and it comes with plenty of strength and mass to do the job. Soil has an intact, in-place structure, based on the interaction of its tiny particles, and this structure is consolidated and fixed by the moisture that constantly moves through it, and by the weight, density and internal pressures that increase in it with depth.

The foundations that engineers design to be inserted or constructed in the soil, have just two basic functions – properly transferring loads into the soil structure, and making a connection to the supported man-made structure above. There have always been two basic types of foundations; Deep Vertical Piling (banged in), or Shallow Spread Footings (dug in and buried). Piling keeps soil strength intact and is easy to install - if you don't have to go too deep. Footings spread the loads more widely, but the digging breaks apart the soil, weakening it and blocking or exaggerating water flow.

There is a third approach though that combines the best features of both, and results in an efficient and soil reinforcing foundation – this is Pin Pile Technology - and it's actually one of the oldest forms of foundations. By grouping short stiff piles, which are easily driven in penetrable soils, and setting them at angles to work more like a shallow footing - spread like a pyramid in the ground - an inexpensive foundation can be created, without digging*. The pile group resembles the roots of a tree, and can actually help to buttress the soil structure it's engaged in. Some of the oldest archeological roadways discovered were supported over soft soils this way - with gangs of short driven timber posts -and in recent decades it has become a reliable technology for complex, heavy-duty commercial applications. It is a state of the art technology, that does a superior job of transferring loads to the soil.

Our innovation is bringing Pin Pile technology into common use with a superior connector - the Diamond Pier. This high strength pre-cast concrete head is a driving guide, pin piling lock and structural connector all in one. As a guide, the pier sets the Pin angles and orientations so their capacity is definable and consistent: as a lock the pier is designed to increase its grip on the Pin cluster when loaded –up, down or sideways – getting stronger and tighter as the loads go higher: and as a connector, an embedded anchor bolt and variable, pre-cast, post matching shape make it a simple and proportional compliment to its supported structures. As a system this hybrid of familiar concrete and steel materials provides a solid, stable foundation, which captures and amplifies the strength of the soil it's engaged in, and in turn, protects the permanent structures it supports.

Pre-Engineered Systems for Frost

If you ask people where the coldest place in the country is they'll probably say Minnesota. That's where we decided a few years ago to introduce our residential Diamond Piers for decks – and it reflects how confident we are in this technology. Are there limits? Of course, but they are the same limits that affect all types of foundations. In frost zones, a properly drained soil with a conventional particle structure will freeze like a fortress, and hold its foundations tight. Most soils have this character, and most buildings are built in these areas. The retail versions of the Diamond Pier -the DP 50, DP 75 and DP 100 - are pre-engineered to perform as well or better than traditional deck foundations in frost zones with these soils - but you have to know your terrain. Non-conventional soils are generally rare in nature, but a lot of weak soil and drainage issues can also be man-made. Pin Foundation Inc's commercial division has the resources and experience to analyze these non-conventional sites, and determine if a custom designed system may be applicable.

Most traditional foundations in frost zones rely on depth and gross weight as protections against frost heave. They use significant volumes of site poured concrete, with the potential for field variables and inconsistent mix designs. Installing these types of foundations also requires considerable digging, leaving substantial amounts of soil to remove from a site, and inviting drainage problems. For Pin Pile Technology in frost zones, Pre-engineered Pin length for the retail Diamond Piers is based on providing sufficient bearing and resistance to uplift loads, rather than reaching a specific vertical depth – and of course keeping the soil structure and existing drainage intact with driven, rather than dug in, installation. Because of the unique design of the Diamond Pier Head, the Pins are also free to move along their axes, without compromising the position of the pier or its lock on the Pin cluster. This feature allows the Diamond Pier to absorb soil strains caused by frost or expansive conditions, without transferring these loads to the supported structure, keeping everything in line, and, again, protecting the structure by doing a superior job working with the soil.

*The environmental advantages of minimizing excavation and reducing concrete volumes are far reaching and significant. Cement manufacture has the third largest carbon footprint in US industry, and digging, whether for the mining of concrete constituents, or for the placing of deep monolithic concrete components, releases more carbon into the atmosphere.

MANUFACTURER'S INSTALLATION INSTRUCTIONS

See also the Installation Video on the website – www.diamondpiers.com.

Know your soils: Bearing strength varies with soil strength. By code, there are two basic penetrable conventional soil types – 2000 psf Sands, and 1500 psf Silts or Clays. Check with your jurisdiction or US Geological Surveys to see which soil bearing strength or soil type applies in your area. Diamond Piers must be installed in properly drained conventional soils. Non-conventional soils include peats, rocky material, unconsolidated or uncompacted fills, contaminated soils, soils with buried debris, highly organic wetland or “hydric” soils, and soils which are weaker than 1500 psf or have water problems.

Check your site: As with any foundation, the Diamond Piers should not be installed in a site depression where there is standing water or where there is the potential for water to pond, pool or saturate the soil. Your site must be properly graded with positive slope to drain both surface and subsurface waters away from the foundations. Do not install the Diamond Piers where downspouts discharge at or near the foundations. Drainage ditches, creeks or nearby ponds, may also indicate an unconventional site and Diamond Piers should be set well away from these features. Confirm that there are no buried Utilities in your Pin driving zone. Do not install Diamond Piers on slopes greater than 2:1 (30 degrees).

Check your layout: The Piers must be spaced a minimum of 3 feet apart – center of bolt to center of bolt. They must also be set back from existing foundations or other buried obstacles, based on Pin length – for 50” Pins use 3.5 ft setback/ 63” Pins, 4.5 ft setback/ 84” Pins, 6 ft setback. The piers should also not be installed in unconsolidated backfill, which often occurs around the excavated perimeter of basement or daylight basement foundations. Tributary Loads from the supported structure must be properly calculated, and the piers spaced accordingly, so that each pier is supporting only up to its designated allowable loads. See the Pier Capacity Load Chart.

Tools and Supplies Verify that you have the correct number of Diamond Piers with the corresponding number of Pins, Pin Caps, and Inspection Plugs, and that the anchor nuts thread properly on the pier anchor bolt. You will need a shovel, automatic driving hammer with driving bit, small sledge hammer, and a short level. We recommend a minimum two person crew for installation. (Do not use the Pin driving Bit as a hammering tool, or hammer against it with the sledge. It is to be used with the automatic hammer only.)

Setting the Concrete Head: Dig a conical hole which is approximately the shape of the bottom half of the concrete pier, and slightly deeper than the pier itself leaving loose soils directly below the pier. Following safe lifting procedures, carefully lift the concrete head, and position it in the hole to its midpoint*, level and centered on your alignment. Replace some of the removed soils back around the sides of the pier at grade, just enough, without packing hard, to maintain level and alignment during Pin driving. *See Pin driving notes below. (*The pier may also be buried deeper for aesthetic considerations if preferred.)*

Pin Driving: Verify locations of any Buried Utilities before Pin Driving Remove any dirt and debris from the Pins and check that they will fit easily in the driving holes of the concrete heads. (If a cut or burr is restricting the fit, try the other end of the Pin) Set the inspection plugs to the ends of the Pins that will go first into the pier. Slide opposing Pins through the driving holes in the concrete head, and, making sure to support them in the center or top of the driving holes, set the Pins a foot or so into the soil with the small sledge hammer. Then drive each Pin alternately in increments with the automatic hammer, periodically checking for plumb and alignment, and keeping the weight of the auto-hammer from forcing the pin against the lower half of the driving hole. Finish driving the Pins with the automatic hammer, being careful not to damage the precast pier, or upper ends of the Pin, and leaving 3/4” of the Pin protruding from the top of the concrete.

Note 1: Do not attempt to drive the pins all the way down with just a sledge hammer as this may damage the ends of the pins or crack the pier.

Note 2: Do not drive a Pin all the way down all at once if this causes the Pier to be pulled to one side. Continue to rotate around the Pier, driving the Pins in increments, until the growing strength in the pile group is sufficient to allow final driving. If driving a given Pin does not cause the pier to go out of level, the Pins may be driven all the way, one at a time.

Note 3: Do not continue to hammer away at a Pin which is bouncing or rattling against an impassable object, if it causes the Pier to ride up the Pin, pushes the pier to one side, or risks eccentrically stressing the pier This may cause the pier to crack, and a cracked pier must be removed and replaced. Ensure that the pier will remain in place if encountering difficulties in the soil, and when following the steps in Note 4.

Note 4: If a Pin meets resistance in the soil while driving, and the obstruction is close enough to the surface, it may be dug up and removed. Once accomplished, re-compact the soils with the sledge hammer, and reset the pier and re-drive the Pin or Pins. The pier may also be turned, or relocated, within the parameters of your superstructure design, in order to avoid underground objects. To relocate a pier, the Pins may be removed by turning them with a pipe wrench and corkscrewing them upward. See “*Pin Removal*” video on the website.

Capping the Pins: Set the caps loosely on the ends of the Pins, so they can be removed for Pin length inspection. Set brackets, and posts or beams, and frame and complete the supported structure. Once these framing material loads have been applied, pull the caps off and re-verify the length of the protruding pins, adjusting as necessary by tapping with the small sledge hammer. Apply an adhesive caulk around the lip of the caps, and seal over the ends of the Pins, tapping the caps down tight to the concrete with the small hammer. We recommend using a 50 year, siliconized, adhesive caulk, or equal, and following the caulk manufacturers application guidelines.

These Installation Instructions are for Residential Retail applications of the Diamond Piers only.

Diamond Pier Load Bearing Capacity Comparison

DP-50	Pin Length		
Values	50"	63"	84"
Bearing in 2000 psf Sands	3600#	N/A	N/A
Bearing in 1500 psf Silts/Clays	2700#	N/A	N/A
Frost Zone Rating	48"	N/A	N/A
Base Area Comparison	18" cylinder		
DP-75	Pin Length		
Values	50"	63"	84"
Bearing in 2000 psf Sands	4000#	4800#	N/A
Bearing in 1500 psf Silts/Clays	3000#	3600#	N/A
Frost Zone Rating	48"	60"	N/A
Base Area Comparison	18" cylinder	21" cylinder	
DP-100	Pin Length		
Values	50"	63"	84"
Bearing in 2000 psf Sands	4200#	5000#	6300#
Bearing in 1500 psf Silts/Clays	3200#	3800#	4700#
Frost Zone Rating	48"	60"	60"
Base Area Comparison	18" cylinder	21" cylinder	24" cylinder

Notes:

Values applicable only in properly drained conventional soils; with a minimum of 1500 psf
 See Definition of Conventional Soils in the Diamond Pier Installation Instructions
 Calculated Values Based on Pin Area Bearing

Uses Limited to Residential Decks, Covered Decks, Stairways and Walkways

Post/Beam Brackets

The bracket needed to make the connection from the Diamond Pier to the superstructure can be purchased separately from a local lumberyard. The DP-50 pier has a 1/2" galvanized bolt embedded in the top of the pier (nut provided), and this bolt will connect to a Simpson Strong-Tie® bracket – model ABA, ABE or ABU - or similar approved post base. Check with your jurisdiction to verify which post bases are acceptable in your area, and make sure to match the post size and loads on the post with the appropriate bracket size and bracket load ratings. Typically these brackets come with a “standoff” design that separates the wood from contact with the base of the bracket, and eliminates the need to drill into the bottom of the lumber to compensate for the raised anchor bolt.

The DP-75 and DP-100 piers have 5/8" diameter bolts at the top of the pier, and there are corresponding brackets available to fit these piers. Horizontal beams may also be set directly in an appropriate bracket for direct connection to the Diamond Pier when constructing low profile structures. If you are using 6x6 posts with the DP-50 pier, make sure to ask your dealer for the DP-50 for 6x6 model.

The proper bracket coating or finish should be chosen based on the lumber to be used and the treating specifications of the project superstructure. If stainless steel is chosen, the embedded galvanized bolt must be protected from contact with the stainless bracket with the addition of a plastic or rubber bushing (not supplied), or the piers must be special ordered with stainless steel bolts.

Most post-base brackets have a wide hole in the base that allows some horizontal adjustment of the final bracket location.

Driving Hammers and Bits

Automatic hammers used for installing the Diamond Pier Pins are listed below. The bits for these automatic hammers all use 1-1/8" hex shafts, and can be rented through a local rental yard, purchased through your lumber dealer, or purchased from Diamond Pier online. Most of the rental yard bits are produced by Bruner & Lay of Chicago (847) 678-3232, and distributed through various rental companies throughout the US - bit model # B 31-861.

Only automatic hammers should be used to install the Diamond Pier Pins, and the bits are meant to be used with these automatic hammers only. The bits are not to be used with, or as, a sledge hammer.

Automatic Hammers for Diamond Pier® Installation

The electric hammers listed have a range of impact energies from 20 to 44 foot/lbs. Soft or loose soils will allow for the use of lighter, lower energy hammers. Stiff or dense soils will require electric hammers in the higher impact range, or standard jackhammers driven by compressed air. In most cases the DP-50 is installed with smaller electric hammers, and the DP-75, & DP-100 with larger electric or compressed air hammers, regardless of soil strength.

MAKITA

<u>Model</u>	<u>HM 1304B</u>
Impact Energy	20.3 ft/#
Bit Type	1 -1/8" Hex
BPM	1450
Weight	35.3#
Length	32.4"

HITACHI

<u>Model</u>	<u>H65SD2</u>
Impact Energy	31 ft/#
Bit Type	1-1/8"
BPM	1400
Weight	40.8#
Length	32.4"

BOSCH

<u>Model</u>	<u>11335K</u> or	<u>11304- BRUTE</u>	-
Impact Energy	34 ft/#	43.0 ft/#	
Bit Type	1-1/8" Hex	1-1/8" Hex	
BPM	1300	1400	
Weight	41.0 #	64 #	
Length	30.0"	30.0"	

MILWAUKEE

<u>Model</u>	<u>5338</u>
Impact Energy	44 ft/#
Bit Type	1-1/8" Hex
BPM	1400
Weight	71.5 #
Length	28.5"

TROUBLE SHOOTING

Cracked Pier Always inspect materials when received from supplier. Do not install a pier that has a crack or fissure running internally into the pier. Slight flaking or chipping does not constitute a crack.

Concrete Flaking While installing, pins rubbing against the pier may cause superficial flaking of concrete around the driving hole. This will not affect the structural strength. However, if a crack or fissure develops during installation, the integrity of the pier has been compromised and the pier must be removed and replaced.

Hitting an Obstruction If an obstruction is encountered, the pins may be removed and the Diamond Pier repositioned. If the obstruction is dug out and removed, soil must be re-compacted per the Installation Instructions. Do NOT cut pins. See Pin Driving Notes in the Installation Instructions.

Pier will not Stay Level when Installing Your hole for setting the pier may be too big. Only dig a hole the size of the pier being used, and be sure to put all pins in the pier before setting them. With all the pins sticking up from the pier, one person can also push or pull on the pins to manipulate the leveling process, and guide or steer the pier to a level position, being careful not to wrench on the pier and cause a crack.

Pier Installed out of Level If a pier is more than 5 degrees out of level, this may compromise the symmetry of the bearing Pins, and it should be removed and repositioned. Re-install the pins slowly at first, checking level constantly, and if one Pin is not going in straight and is causing the pier to tip, install the other Pins first, then carefully finish driving this last Pin.

Pins have Risen Slightly Out of the Concrete Head This may occur when extreme loads have been applied to the pier, but the system is designed to relieve pressure in this way. The Pins may simply be tapped back to their original position with a small hammer.

Pins will not Fit into the Pier Make sure Pins fit into the pier before inserting the inspection plugs. Be sure Pins and Piers are free of dirt and check both ends for fit. Always transport and store in a clean environment. Measure Pin diameter to be sure the proper Pins have been supplied for your pier model. (DP50 - 1"nominal pin is 1.315" actual outside diameter. DP75 - 1¼"nominal pin is 1.67" actual OD, DP100 - 1 ½"nominal pin is 1.9" actual OD). If pins still do not fit, contact your supplier.

Caps will not Fit over the Driven Pins Check to be sure proper cap size was supplied (see Pin outside diameters above), and that your caps are pliable and not frozen. Cap should be tapped on with a small hammer. If they still will not go on, check the Pin ends for any extreme deformations that may have occurred while driving. File or grind off any damage to reestablish the original diameter, and apply the cap.

Post Looks too Big for the Top of the Pier 4x4 and 4x6 posts can be used on all Diamond Pier sizes, and 6x6 posts can be used on the DP-100, DP-75 and DP-50/6x6 models. When installing, be sure the loads of all post sizes are properly transferred to the top of the concrete with appropriate brackets. If you have a DP-50/4x4 model pier already installed, and you're planning to put a 6x6 post on it, the bracket may need to be blocked with composite or pressure treated wood between the base of the bracket and the underside of the standoff fitting. If you haven't installed the pier(s) yet, ask your dealer for the DP50 for 6x6 model instead.

Diamond Pier is Not Approved Yet in your Jurisdiction Make sure to include the Diamond Piers on your permit application along with the ESR1895 report for the DP-50, the Frost Performance Reports and Alternate Methods cover letter. (Go to www.diamopndpiers.com for downloadable cover letter text) Make sure that you are applying for only the allowable Diamond Pier uses (decks, covered decks, stairs, and walkways), and that the designed loads to be supported are within the allowable capacities of the Diamond Pier model indicated for the soils on your site. If the Building Official is still denying the product, request a written explanation of how the Diamond Pier does not meet the intent of code in their jurisdiction, and forward this request and the Building Official's response to Pin Foundations, Inc.

Field Inspection

Note: Diamond Pier foundation inspection can take place at any time after installation, and can be combined with the superstructure framing inspection as each jurisdiction warrants.

Pin Length - Diamond piers are designed to be inspected from above grade, after they have been installed. Provided the builder uses the inspection plugs at the lower (driven) end of the Pin to keep soils from moving up inside it, a tape measure can be slid down from the top of the installed Pin to verify its length.

Note: – if framing members will be too close to the top of the pier to allow the tape measure to be inserted, this inspection should be done before this framing is in place. Also, if the builder has not used inspection plugs, pins may also be twisted out with a pipe wrench to verify their length. They may then be re-driven in the same soil cavity. Pins are to be their full specified length (length tolerance is +/- 1/2"). A Pin that has been cut in the field will have an irregular, rough end at the cut.

Pin Specification – Pins are to be schedule 40 galvanized pipe, electric resistance welded, with no threads. This also can be verified from the top of the pier. With the rubber cap removed, the weld can be verified on the inside wall of the Pin, and the wall thickness can be checked. If the wall thickness is thinner than specified, the Pins have been substituted with a lower schedule pipe or conduit, and must be replaced with the properly specified Pins. 1" nominal, schedule 40 pipe has a wall thickness of 0.133 inches (just over 1/8"). 1-1/4" nominal, schd 40 pipe has a wall thickness of 0.140 inches, and 1-1/2" nominal, schd 40 pipe has a wall thickness of 0.145 inches. The tolerance is +/- 1%.

Pier Integrity – If the Installation Instructions are properly followed, the piers should be level (within a 5 degree tolerance), and they should not have structural cracks as a result of improper handling or driving. (Surface spalls or chips may occur during driving or handling, but these are not structural, and will not affect the pier.) A structural crack is perpendicular to the outer face of the pier and heads inward to the core. This can weaken the pier strength, and/or allow water to penetrate and cause freeze/thaw problems in the concrete. If a pier is more than 5 degrees out of level, the symmetry of the Pin pairs may be compromised, and the pier should be removed and correctly re- installed. If a pier has a structural crack, it should NOT be patched. It should be removed and replaced.

Allowable Capacity – The piers should not be overloaded. The total load on any specific pier is based on the individual tributary loads of the structure, supported by the corresponding post or beam connected to the pier. This weight is a combination of either snow or people (live load), and the weight of the deck structure itself (dead load). The total tributary load – area x psf (LL+DL) - should not exceed the published capacity of the pier.

References/Standards

- A. ASTM A 53 - Pipe, Steel, Black and Hot dipped, Zinc-coated
- C. ASTM A153 - Zinc coating (hot-dip) on Steel Hardware
- D. ASTM, ACI and CRSI standards for precast concrete products

Delivery/Storage and Handling

- A. Contractor shall protect the materials from damage.

Pins

- A. Four pins per pier. All Pins to be galvanized steel pipe with butt cut driving ends, schedule 40 – Grade A, Type E electric resistance welded -Pins to be capped with UV resistant vinyl caps, and sealed.

Connections/Posts/Beams

- A. Diamond Pier connection to be galvanized steel post base (by others) attached to pier with single cast-in galvanized anchor bolt.

Site

- A. Alteration of site soils or vegetation to be kept to a minimum to avoid erosion, drainage issues, or the need for re-vegetation.

Installation

- A. Contractor shall verify superstructure layout, spans and resulting loads for consistency with the manufacturer's published capacities,
- B. Pins to be full length as specified before driving. No coupled or welded pins are to be used.
- C. Follow Manufacture's Installation Instructions

INSPECTION PLUGS

These hard plastic plugs keep soil from moving up the inside of the Diam and Pier[®] Pins, allowing inspectors to slide a tape measure down the Pin from above to verify its length. If you have Pins with an interior weld bead, align the slot in the plug with the weld before inserting. The allowable tolerance in Pin wall thickness means that some plugs will fit high in the end of the Pins, and some will fit down almost to the plug shoulder. In either case, tap the point of the plug with a hammer to seat it firmly enough in the end of the Pin, so that it will not drop out as you slide it through the Pier sleeves. Don't worry that tapping the end of the plug with the hammer will blunt the point. This would happen anyway as the plug is driven into the soil.

