

low impact development technical workshop series

PIN Foundations

Topics

Applications

Design and Construction

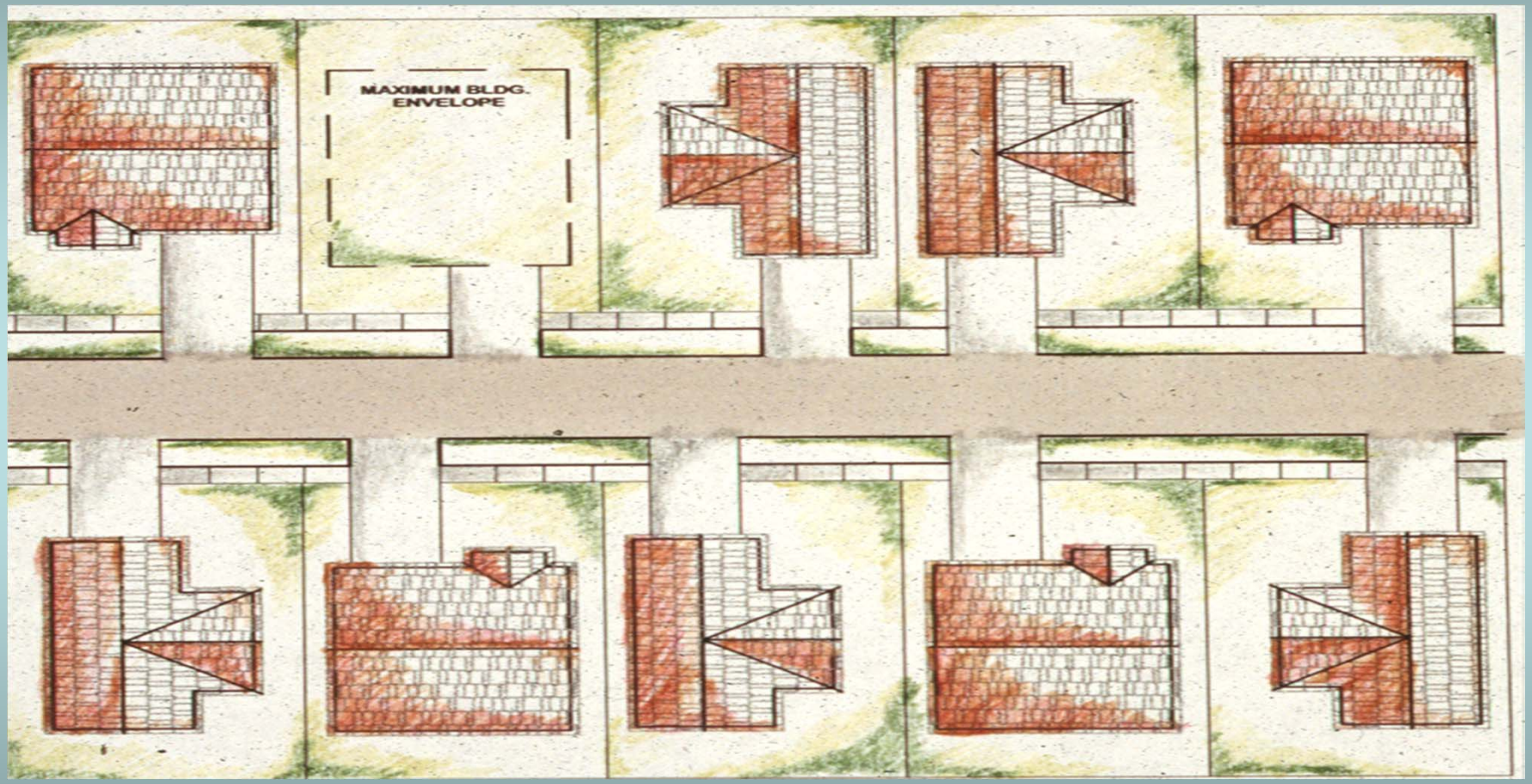
Flow Control Credits

WASHINGTON STATE UNIVERSITY EXTENSION

www.pinfoundations.com

Curtis Hinman
Senior Scientist
Herrera Environmental Consultants
chinman@herrerainc.com

The challenge is to better maintain native characteristics of soils during and after construction

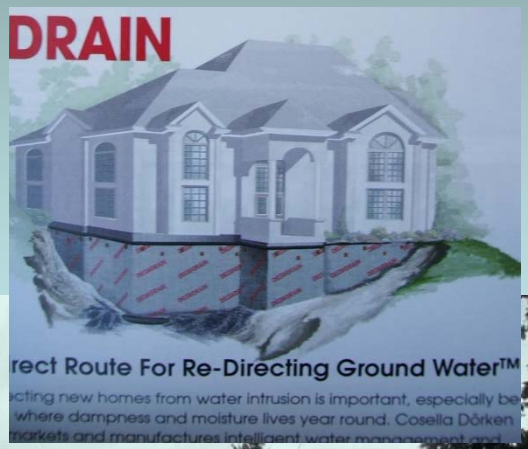


In a typical, dense residential development there can be 50% more roof than road impervious area.

The typical construction approach is to strip, cut, fill and pound

lid foundations

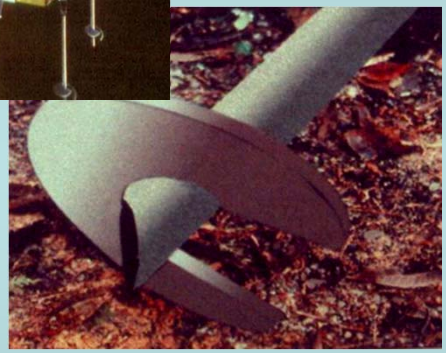
Management of large clearing and grading operations expensive and time consuming.



lid foundations

Other Foundation Systems

Minimal footprint



Screw anchors

Vertical piling

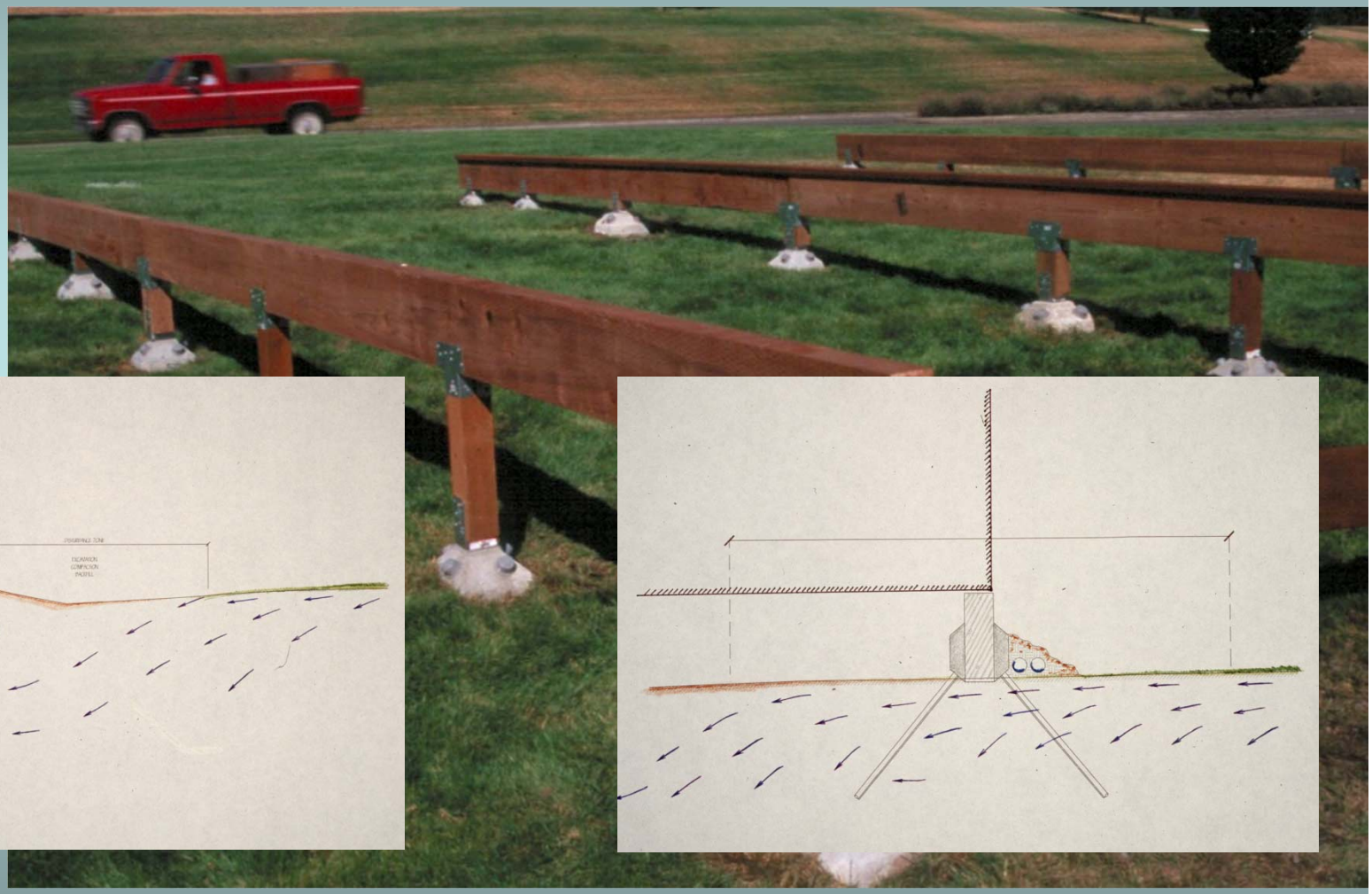
Heavy Equipment

Site Pours

Carbon Release

lid foundations

The challenge is to better maintain native characteristics of soils during and after construction



lid foundations

Wall Systems

Preparation

- Remove minimal material.
- Pea gravel then foam (isolates wall).
- Place forms, pour and drive pins.

Pin placement

- Preferred method is to place pins after pour.
- Can place pins before pour.

Can be applied to different construction applications.

lid foundations

Wall Systems

Can be used on slopes (stepped) but strormwater credit is reduced due to additional soil disturbance.

Conventional construction from the foundation up with some additional considerations.

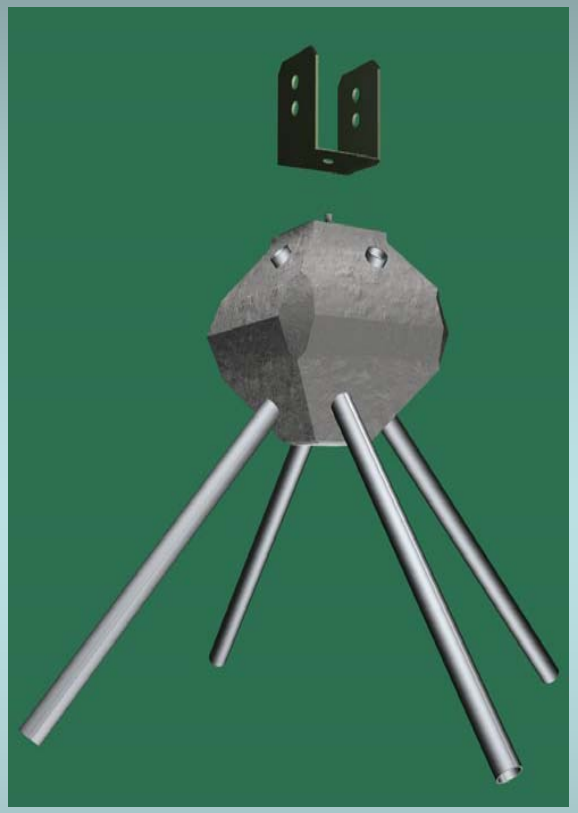
lid foundations

Diamond Piers

- Reduced weight and volume
- No excavation, grading or site pours

Battered Pile Groups
with Precast Concrete

Diamond Piers

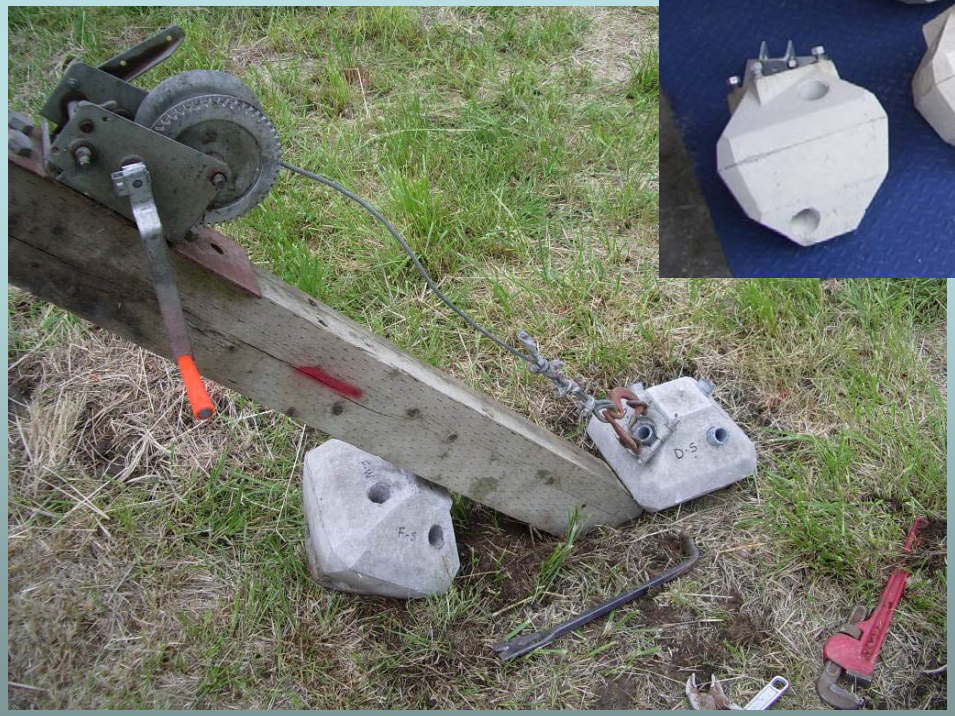


- DP 50: 50 lbs. residential decks, 1 inch pins.
- DP 75: 75 lbs. homes and light commercial, 1.25 inch pins.
- DP 100: 100 lbs. homes and light commercial, 1.5 inch pins.
- DP 200: 200 lbs. homes and light commercial, 2.0 inch pins.

lid foundations

Diamond Piers

- Removable Pins
- Bracket Adjustment
- Height Adjustment



Diamond Pier Installation

- Two or three person crew.
- 20-30 minutes per pier.
- No excavation, heavy equipment or site repair.

lid foundations

Diamond Pier Installation

- Picking the right hammer: primarily driven by soil type determined during initial design.
- Installing pins...

lid foundations

Diamond Pier Installation

Removing pins...pin sits ~3/4 in above pier.

One and four bolt bracket configurations.

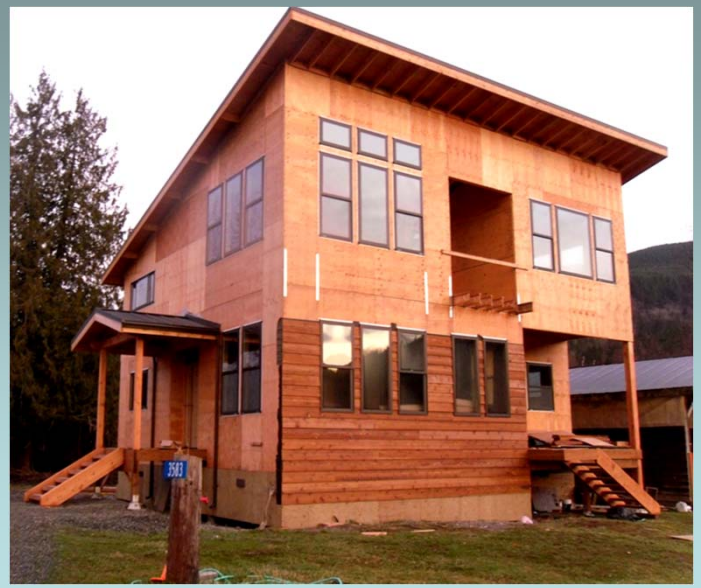
Height adjustment.

lid foundations

Diamond Pier Installation

Framing and utilities

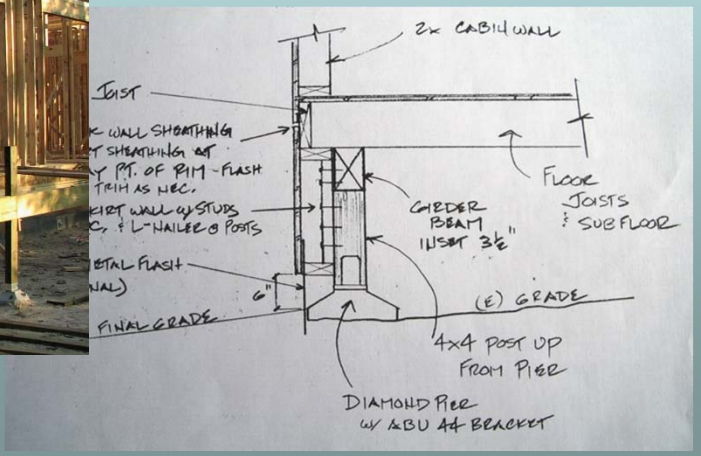
DP Structures



DP Structures

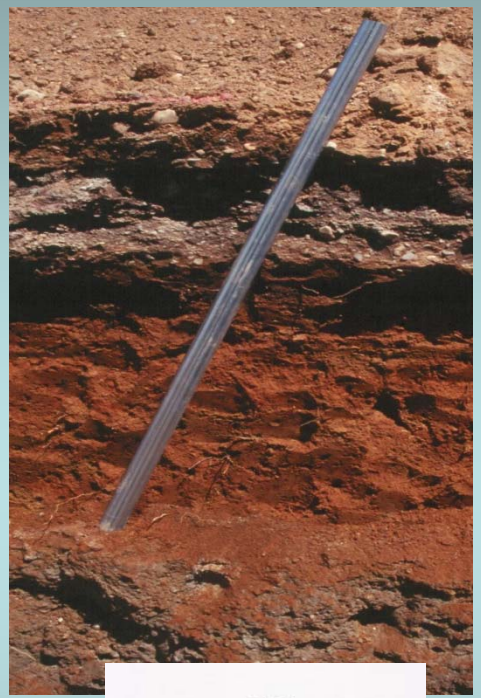
DP Structures

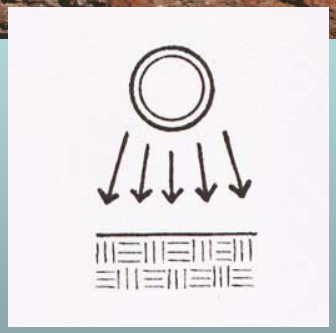
Typical foundation ~ 14 yds or 28 tons of concrete. DP foundation ~ 1/6 the concrete.



lid foundations

Diamond Pier Design





- Phi angle: internal angle of friction…describes how granular soils hold up when stacked.
- Cohesive strength: characteristic of clay soils.
- In place unit weight.

PIN FOUNDATIONS INC.

Calculation Software for Pin Foundation System

PROJECT INFORMATION:

Project Name:	CENTEX HOMES
Product:	L.I.F.T.
Location:	Auburn, WA
Engineer:	TAN
Date:	8/16/04

SOIL INFORMATION:

	Soil 1 - Thickness (ft), D1:1.50	**Soil 2**
Description:	Organic Silts and Clayey Silts	Silty Sands
Phi (degree):	24.00	28.00
Unit Weight (pcf):	95.00	105.00
Cohesion (psf):	150.00	50.00
Ground Water Table:	At Grade	
Neglected Depth (ft):	0.50	

PILE INFORMATION:

Pile Type:	Inboard (2 pins)
Pin Length (ft):	**5.25**
Angle (degree):	40.00
Pin Diameter (in):	2.375
Wall Thickness (in):	0.179
Pin Type and Grade:	Pipe, 36ksi
Effective Depth (ft), D:	3.04
Effective Length (ft), B:	5.95
Effective Pile Width (ft):	0.54

Program automatically corrects Dry Unit Weight for Buoyant Weight when Ground Water Table "At Grade" is indicated.

Program corrects total Pin length indicated for actual active length.

PILE CAPACITY:

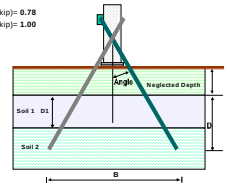
Compression:	C_ultim (kip)= 14.17
F.S.=2:	C_allow (kip)= **7.08**
Uplift:	U_ultim (kip)= 1.40
F.S.=1.5:	U_allow (kip)= **0.93**
Lateral:	
Parallel to Pins:	L1_allow (kip)= **0.78**
Perpendicular to Pins:	L2_allow (kip)= **1.00**

All capacities are calculated separately.

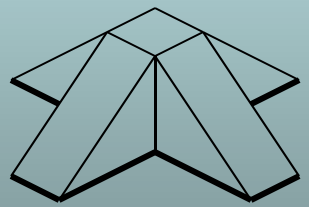
CALCULATION DATA:

Bearing Capacity Factors:
- Nc=27.16
- Nq=14.25
- Nr=10.75

Pressure at Base (psf)=114.63
Arching Factor=2.75
Allowable Deflection (in)=0.5
Allowable Bending Stength (ksi)=24



PIN FOUNDATIONS INC. 2003 V4.0 Software Developed by CivilTech Software, Bellevue,WA,USA www.civiltech.com



4 pins of equal length per pier. Pin length includes that portion embedded in the pier.

Diamond Pier Design

PIN FOUNDATIONS INC.

Calculation Software for Pin Foundation System

PROJECT INFORMATION:

Project Name:	CENTEX HOMES
Product:	L.I.F.T.
Location:	Auburn, WA
Engineer:	TAN
Date:	8/16/04

SOIL INFORMATION:

	Soil 1 - Thickness (ft), D1:1.50	**Soil 2**
Description:	Organic Silts and Clayey Silts	Silty Sands
Phi (degree):	24.00	28.00
Unit Weight (pcf):	95.00	105.00
Cohesion (psf):	150.00	50.00
Ground Water Table:	At Grade	
Neglected Depth (ft):	0.50	

PILE INFORMATION:

Pile Type:	Inboard (2 pins)
Pin Length (ft):	**5.25**
Angle (degree):	40.00
Pin Diameter (in):	2.375
Wall Thickness (in):	0.179
Pin Type and Grade:	Pipe, 36ksi
Effective Depth (ft), D:	3.04
Effective Length (ft), B:	5.95
Effective Pile Width (ft):	0.54

Program automatically corrects Dry Unit Weight for Buoyant Weight when Ground Water Table "At Grade" is indicated.

Program corrects total Pin length indicated for actual active length.

PILE CAPACITY:

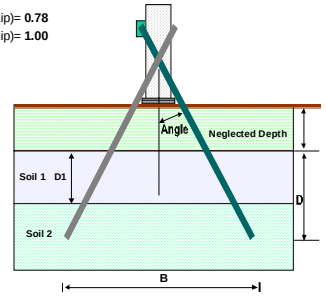
Compression:	C_ultim (kip)= 14.17
F.S.=2:	C_allow (kip)= **7.08**
Uplift:	U_ultim (kip)= 1.40
F.S.=1.5:	U_allow (kip)= **0.93**
Lateral:	
Parallel to Pins:	L1_allow (kip)= **0.78**
Perpendicular to Pins:	L2_allow (kip)= **1.00**

All capacities are calculated separately.

CALCULATION DATA:

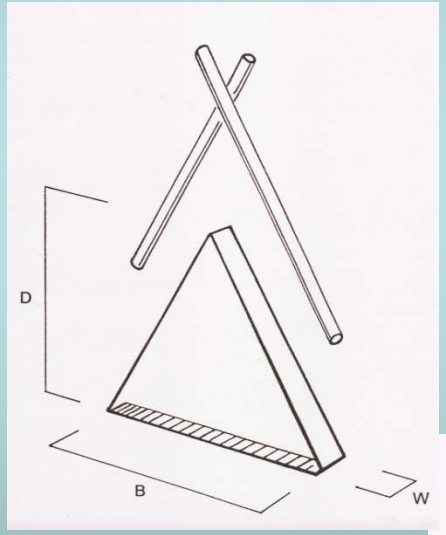
Bearing Capacity Factors:
- Nc=27.16
- Nq=14.25
- Nr=10.75

Pressure at Base (psf)=114.63
Arching Factor=2.75
Allowable Deflection (in)=0.5
Allowable Bending Stength (ksi)=24



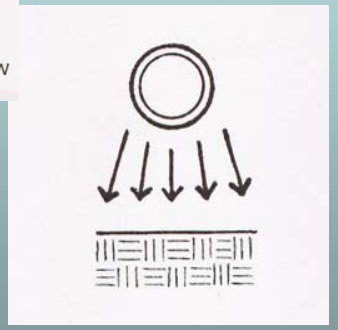
PIN FOUNDATIONS INC. 2003 V4.0 Software Developed by CivilTech Software, Bellevue,WA,USA www.civiltech.com

Consider phi angle, cohesive strength and unit weight to determine equivalent bearing area.



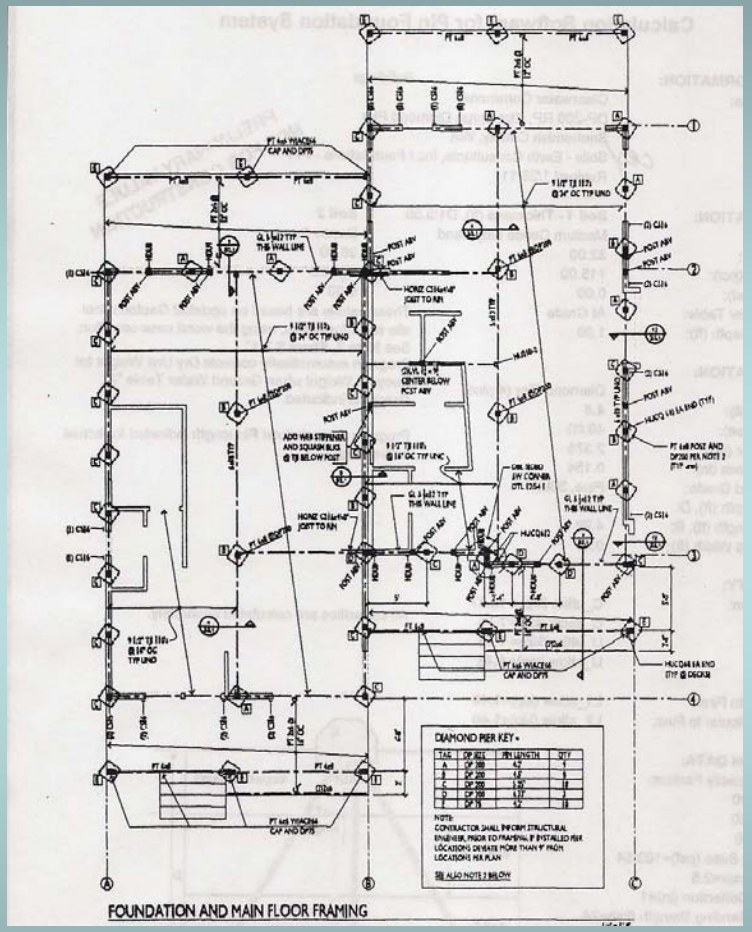
Can cut pin if obstacle encountered, but 60% of length should remain.

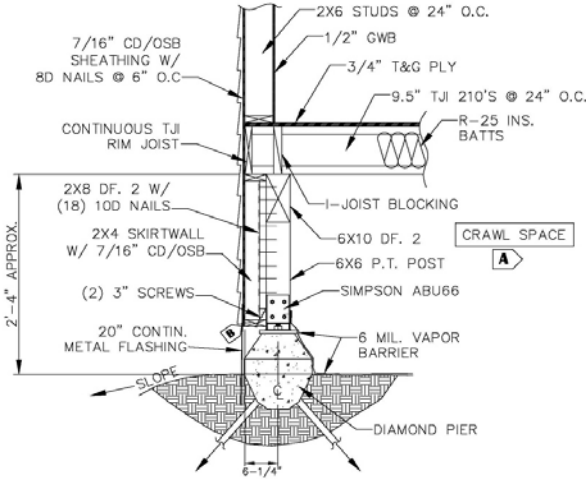
Arching factor: 2x pile diameter.



lid foundations

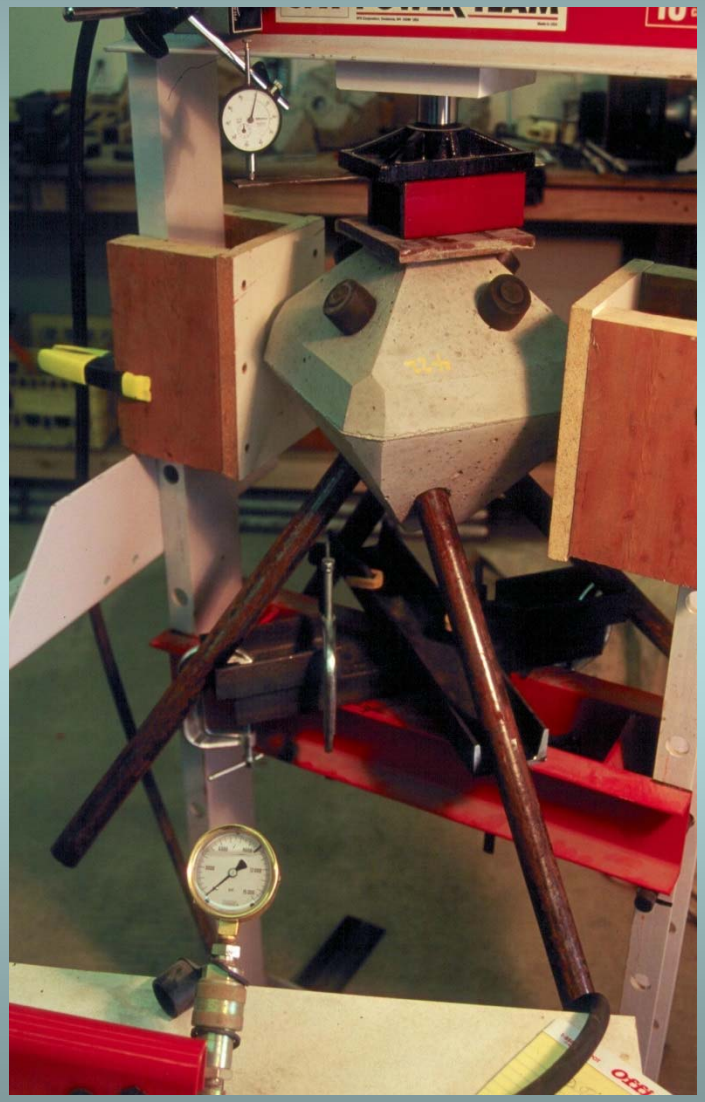
Diamond Pier Submittals





PIN Inc. uses soil work to determine pier configuration. Architect determines loads and location of piers.

Structural Testing



- Concrete head restricts pin from changing angle and provides platform for structure...not load bearing.
- Structural limits

  DP-100: 9000 Pounds

lid foundations

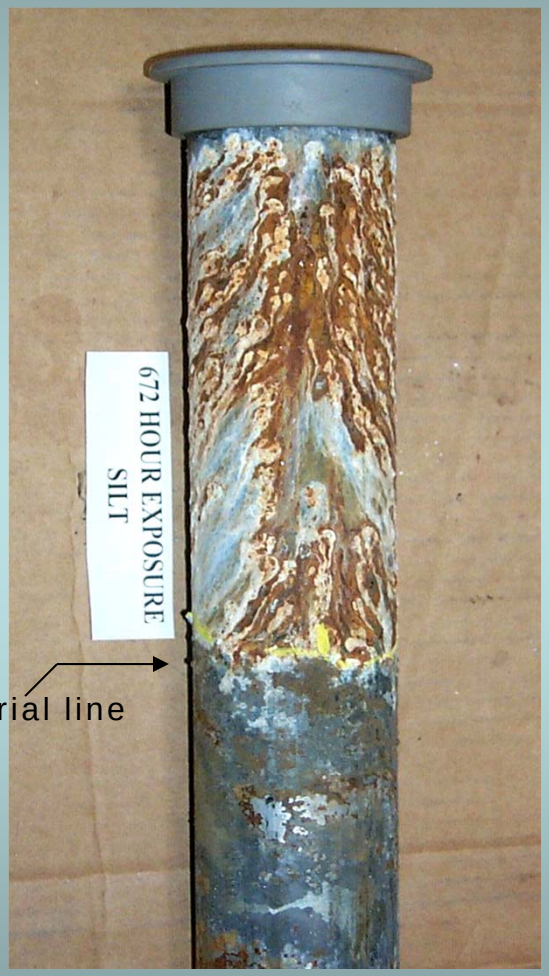
Structural Testing and Certification

Prescriptive load chart in normal construction conditions (soils, structure and site) for DP 50 and 75.

DP 100 and 200 requires soil testing and analysis (site specific) for load.

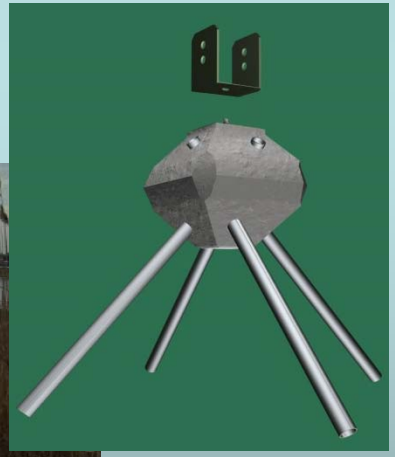
lid foundations

Performance and Durability



Salt Spray Corrosion Test - PSI

- Frost soil heave: pin angle retards uplift and point of pier cleaves/deflects soil around pier.
- Corrosion protection: low oxygen environment reduces corrosion.



lid foundations

Cost

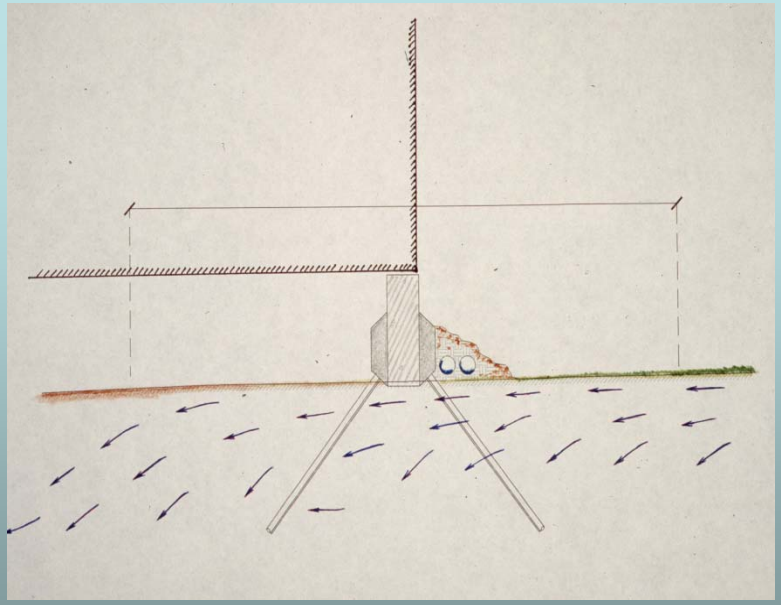
- Pier costs = 2.5x model # (e.g. DP 100 = $250).
- Cost driven by house size and load paths...i.e. number of piers.
- For poor soils DP cost increase ~ 10-15%. Conventional foundation can increase several hundred percent.
- If stormwater requirements not triggered SFR may not realize savings...that is changing.
- At subdivision scale reduced grading and excavating, and improved stormwater management can induce savings.

lid foundations

Flow Control Credits

No step forming

- Model as pasture on existing soil if roof runoff is dispersed on the up gradient side of structure according to BMP T5.10 (best flow control credit for low impact foundations).



lid foundations

Flow Control Credits

Step forming

- Use equation below to determine what portion of roof can be modeled as pasture on existing soil:

$$A_1 - [dC(0.5)/dP] \times A_1 = A_2$$

A_1 = roof area draining to up gradient
dC = depth of cuts into soil profile
dP = permeable depth of soil (A horizon + some B horizon)
A_2 = roof area modeled as pasture on existing soil