COMMON DRIVEN PILE TYPES

- Steel Pipe
- Timber
- Steel H
- Precast Concrete
- Composite
# Timber Pile Overview

| TYPICAL LENGTHS:          | 15 to 75 feet – Southern Pile  
|                          | 15 to 120 feet – Douglas Fir |
| MATERIAL SPECIFICATIONS:  | ASTM D-25  
|                          | AWPA-UC4A, 4B, 4C, 5B, and 5C |
| MAXIMUM STRESSES:         | Typical Design Stress: 0.8 to 1.2 ksi  
|                          | (based on pile toe area)  
|                          | Driving Stress: 3 x Design Stress |
| DESIGN LOADS:             | 10 to 55 tons |
| ADVANTAGES:               | Comparatively low initial cost.  
|                          | Easy to handle.  
|                          | Resistance to decay if permanently submerged. |
| DISADVANTAGES:            | Vulnerable to decay if untreated and intermittently submerged.  
|                          | Vulnerable to damage at pile head and pile toe in hard driving.  
|                          | Difficult to splice. |
| REMARKS:                  | Best suited for friction pile in granular soil. |
Timber Piles
Timber Piles
Timber Pile - Toe Protection
# H-Pile Overview

<table>
<thead>
<tr>
<th><strong>TYPICAL LENGTHS:</strong></th>
<th>15 to 120 feet</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MATERIAL SPECIFICATIONS:</strong></td>
<td>ASTM A-572, A-588, or A-690 ( F_Y = 50 \text{ ksi} )</td>
</tr>
</tbody>
</table>
| **MAXIMUM STRESSES:** | Typical Design Stress: 0.25 to 0.33 \( F_Y \) \( (12.5 \text{ to } 16.5 \text{ ksi}) \)  
Driving Stress: 0.90 \( F_Y \) \( (45.0 \text{ ksi}) \) |
| **TYPICAL DESIGN LOADS:** | Standard H Sections (8 to 14 inch): 66 to 284 tons  
Newer H Sections (16 to 18 inch): 161 to 495 tons |
| **ADVANTAGES:** | Available in various sizes, sections and lengths.  
Easy to splice.  
High capacities possible.  
Low soil displacements.  
May penetrate larger obstructions with driving shoes. |
| **DISADVANTAGES:** | Vulnerable to corrosion.  
Not recommended as friction pile in granular soil. |
| **REMARKS:** | Best suited for toe bearing on rock. |
H-Piles
New Larger H-Pile Sections

HP 18 x 204, $A_s = 60.0 \text{ in}^2$
H-Pile - Toe Protection
H-Pile - Splices

Full Penetration Groove Weld

H-pile Splicer
H-Pile - Splices

1. Cut notch ⅜” x 2½”
   Scarf flanges

2. Slip Splicer on, weld
   2½ in. each edge.

Stand on driven pile.
Weld opposite edges.
Weld across flanges.
# Open End Pipe Pile Overview

<table>
<thead>
<tr>
<th><strong>TYPICAL LENGTHS:</strong></th>
<th>15 to 150 feet or greater</th>
</tr>
</thead>
</table>
| **MATERIAL SPECIFICATIONS:** | ASTM A-252, Grade 2 or 3 (F<sub>y</sub> = 35.0 or 45.0 ksi)  
ACI 318 – for concrete (if filled)  
ASTM A-572 – for core (if used) |
| **MAXIMUM STRESSES:** | Typical Design Stress: 0.25 F<sub>y</sub> to 0.33 F<sub>y</sub> (on steel)  
+ 0.40 f’c (on concrete)  
Driving Stress: 0.90 F<sub>y</sub> (31.5 to 40.5 ksi) |
| **TYPICAL DESIGN LOADS:** | 80 to 1500 tons |
| **ADVANTAGES:** | Available in various lengths, diameters, and wall thicknesses.  
Pile can be cleaned out and driven deeper.  
Easy to splice.  
High capacities possible.  
Low soil displacements. |
| **DISADVANTAGES:** | Vulnerable to corrosion. |
| **REMARKS:** | High bending resistance on unsupported length. |
Outside Cutting Shoe
Inside Cutting Shoe
Large Diameter Open End Pipe
### Closed End Pipe Pile Overview

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</table>
| **MATERIAL SPECIFICATIONS:** | ASTM A-252, Grade 2 or 3 (F<sub>Y</sub> = 35.0 or 45.0 ksi)  
ACI 318 – for concrete (if filled) |
| **MAXIMUM STRESSES:** | Typical Design Stress: 0.25 F<sub>Y</sub> (on steel)  
+ 0.40 f’c (on concrete)  
Driving Stress: 0.90 F<sub>Y</sub> (31.5 to 40.5 ksi) |
| **TYPICAL DESIGN LOADS:** | 40 to 300 tons |
| **ADVANTAGES:** | Available in various lengths, diameters, and wall thicknesses.  
Pile can be cleaned out and driven deeper.  
Easy to splice.  
High capacities possible. |
| **DISADVANTAGES:** | Soil displacements. |
| **REMARKS:** | High bending resistance where unsupported length is laterally loaded. |
Typical Pipe Pile Closure Plate

- Flat Closure Plate
- Fillet Weld

Diagram:
- Flat Closure Plate

Image:
- Rusty pipe pile with closure plate attached.
Conical Pipe Pile Tip
Pipe Pile - Splicing

Full Penetration Groove Weld
Pipe Pile - Splicing

Friction Splicer
# Monotube Pile Overview

<table>
<thead>
<tr>
<th><strong>TYPICAL LENGTHS:</strong></th>
<th>15 to 80 feet</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MATERIAL SPECIFICATIONS:</strong></td>
<td>SAE-1010 - for steel ($F_Y = 50.0$ ksi) ACI 318 - for concrete</td>
</tr>
<tr>
<td><strong>MAXIMUM STRESSES:</strong></td>
<td>Typical Design Stress: $0.25 F_Y$ (on steel) + $0.40 f'c$ (on concrete) Driving Stress: $0.90 F_Y$ (31.5 to 40.5 ksi)</td>
</tr>
<tr>
<td><strong>TYPICAL DESIGN LOADS:</strong></td>
<td>45 to 200 tons</td>
</tr>
<tr>
<td><strong>ADVANTAGES:</strong></td>
<td>Can be inspected after driving. Tapered pile section provides high resistance in granular soils.</td>
</tr>
<tr>
<td><strong>DISADVANTAGES:</strong></td>
<td>Soil displacements.</td>
</tr>
<tr>
<td><strong>REMARKS:</strong></td>
<td>Best suited for friction pile in granular soils.</td>
</tr>
</tbody>
</table>
Monotube Piles
Monotube Splicing

Cut V Notches at 90°

Grind V Notches

Fillet Weld
# Tapertube Pile Overview

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<th>15 to 80 feet or greater</th>
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</table>
| **MATERIAL SPECIFICATIONS:** | ASTM A-252, Grade 3 (F_Y = 45.0 ksi)  
ACI 318 – for concrete (if filled) |
| **MAXIMUM STRESSES:** | Typical Design Stress: 0.25 F_Y (on steel)  
+ 0.40 f’c (on concrete)  
Driving Stress: 0.90 F_Y (31.5 to 40.5 ksi) |
| **TYPICAL DESIGN LOADS:** | 50 to 180 tons |
| **ADVANTAGES:** | Can be internally inspected after driving.  
Tapered pile section provides high resistance in granular soil. |
| **DISADVANTAGES:** | Soil displacements. |
| **REMARKS:** | Best suited for friction pile in granular soils. |
Tapertube Piles
### Cast-In-Place (Mandrel Driven)

<table>
<thead>
<tr>
<th><strong>TYPICAL LENGTHS:</strong></th>
<th>50 to 80 feet  (shorter and longer lengths possible)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MATERIAL SPECIFICATIONS:</strong></td>
<td>ACI 318 – for concrete</td>
</tr>
</tbody>
</table>
| **MAXIMUM STRESSES:** | Typical Design Stress: 0.33 f’c  (0.40 f’c may be allowed)  
Driving Stress: function of mandrel and pile shell |
| **TYPICAL DESIGN LOADS:** | 45 to 150 tons. |
| **ADVANTAGES:** | Initial economy.  
Can be internally inspected after driving.  
High resistance in granular soils if tapered. |
| **DISADVANTAGES:** | Thin shell vulnerable to damage or collapse.  
Redriving not recommended.  
May be difficult to splice.  
Soil displacements. |
| **REMARKS:** | Best suited for friction pie in granular soils. |
Cast-In-Place (Mandrel Driven)
Cast-In-Place (Mandrel Driven)
## Prestressed Concrete Overview

<table>
<thead>
<tr>
<th><strong>TYPICAL LENGTHS:</strong></th>
<th>30 to 130 feet</th>
</tr>
</thead>
</table>
| **MATERIAL SPECIFICATIONS:** | ACI 318 – for concrete  
ASTM A-416, A-421, and A-882 for prestress |
| **MAXIMUM STRESSES:** | Design Stress: $0.33 f'c – 0.27 f_{pe}$ (on gross concrete area)  
Driving Stress: $0.85 f'c – f_{pe}$ (in compression)  
$3 \sqrt{f'c} + f_{pe}$ (in tension) |
| **DESIGN LOADS:** | 40 to 300 tons |
| **ADVANTAGES:** | High load capacity.  
Corrosion resistance obtainable.  
Hard driving possible. |
| **DISADVANTAGES:** | Higher breakage rate.  
Soil displacements.  
Can be difficult to splice |
| **REMARKS:** | Cylinder piles well suited for bending resistance. |
Prestressed Concrete
Prestressed Concrete Details

Typical Sizes

- Square Solid: 10 – 20 inch
- Square Hollow: 20 – 36 inch
- Octagonal Solid or Hollow: 10 – 24 inch
- Void: 11 – 18 inch void

*Continuous Tie, Prestressing Strand*
Concrete Pile Splices

Wedge

Plan

Pinned

Sleeve

Connector Ring

Mechanical

Welded

Dowel
Mechanical Splice
Epoxy-Dowel Splice
Spun Cast Concrete Cylinder Piles
Spun Cast Concrete Cylinder Piles

Pile Properties
High strength concrete, $f'c = 7$ ksi, $f_{pe} = 1.2$ ksi
16 ft long pile segments (typical)
Segments combined and post-tensioned

Typical Sizes
36, 42, 48, 54, & 66 inch O.D.
5 & 6 inch wall

Typical Design Loads
250 to 800 tons
ICP Spun Cast Pile

Pile Properties

High strength concrete
f’c = 10 ksi, f_{pe} = 1 ksi
20 to 120 ft long segments
Welded pile splice

Typical Pile Sizes

9.8 to 47.2 inch O.D.
2.2 to 5.9 inch wall

Typical Design Loads

80 to 1100 tons
ICP Spun Cast Pile

Welded Splice
## Composite Piles - Overview

<table>
<thead>
<tr>
<th><strong>TYPICAL LENGTHS:</strong></th>
<th>50 to 200 feet.</th>
</tr>
</thead>
</table>
| **MATERIAL SPECIFICATIONS:** | ASTM A-572 for H-pile sections  
ASTM A-252 for pipe pile sections  
ACI 318 – for concrete  
ASTM D25 for timber sections |
| **MAXIMUM STRESSES:** | Typical Design Stress: Depends on pile materials  
Driving Stress: Depends on pile materials |
| **TYPICAL DESIGN LOADS:** | 30 to 200 tons |
| **ADVANTAGES:** | May solve unusual design or installation problems.  
High capacity may be possible depending on pile materials.  
May reduce foundation costs. |
| **DISADVANTAGES:** | May be difficult to attain good joint between pile materials. |
| **REMARKS:** | Weakest pile material controls allowable stresses and capacity. |
Concrete – H-pile

Pipe – H-pile

Composite Piles
Composite Piles

Pipe - Concrete

Corrugated Shell - Timber
Pile Selection

• Practice of having a standard or favorite pile type is **NOT** recommended

• Each type has advantages & disadvantages

• Several pile types or sections may meet the project design requirements
Pile Selection

Therefore, all candidate pile types should be carried forward in the design process.

Final pile selection should be based on most economical section meeting the design requirements.
Site Considerations on Pile Selection

Impact of vibrations on nearby structures.

Remote areas may restrict equipment size.

Local availability of pile materials and capabilities of local contractors.

Waterborne operations may dictate use of shorter pile sections.

Steep terrain may make use of certain pile equipment costly or impossible.
## Subsurface Effects on Pile Selection

<table>
<thead>
<tr>
<th>Typical Problem</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulders over Bearing Stratum</td>
<td>Use Heavy Low Displacement Pile With Shoe. Include Contingent Predrilling Item in Contract.</td>
</tr>
<tr>
<td>Loose Cohesionless Soil</td>
<td>Use Tapered Pile to Develop Maximum Shaft Resistance.</td>
</tr>
<tr>
<td>Negative Shaft Resistance</td>
<td>Avoid Batter Piles. Use Smooth Steel Pile to Minimize Drag Load or Use Bitumen Coating or Plastic Wrap. Could Also Use Higher Design Stress.</td>
</tr>
<tr>
<td>Deep Soft Clay</td>
<td>Use Rough Concrete Piles to Increase Adhesion and Rate of Pore Water Dissipation.</td>
</tr>
</tbody>
</table>
## Subsurface Effects on Pile Selection

<table>
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<th>Typical Problem</th>
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<tr>
<td>Artesian Pressure</td>
<td>Hydrostatic Pressure May Cause Collapse of Mandrel Driven Shell Piles and Thin Wall Pipe. Pile Heave Common on Closed End Pipe.</td>
</tr>
<tr>
<td>Scour</td>
<td>Adequate Pile Capacity Should be Developed Below Scour Depth (Design Load x SF). Tapered Pile Should Be Avoided Unless Taper Extends Below Scour Depth.</td>
</tr>
<tr>
<td>Coarse Gravel Deposits</td>
<td>Use Prestressed Concrete Piles Where Hard Driving is Expected.</td>
</tr>
</tbody>
</table>
**Pile Shape Effects on Pile Selection**

<table>
<thead>
<tr>
<th>Shape Characteristic</th>
<th>Pile Types</th>
<th>Placement Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displacement</td>
<td>Closed End Steel Pipe</td>
<td>Increase Lateral Ground Stress.</td>
</tr>
<tr>
<td></td>
<td>Prestressed Concrete</td>
<td>Densify Cohesionless Soils.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Temporarily Remolds and Weakens Cohesive Soils.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Setup Time for Large Pile Groups in Sensitive Clays May Be Up To Six Months.</td>
</tr>
</tbody>
</table>
# Pile Shape Effects on Pile Selection

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<tr>
<th>Shape Characteristic</th>
<th>Pile Types</th>
<th>Placement Effects</th>
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</thead>
<tbody>
<tr>
<td>Low Displacement</td>
<td>Steel H-pile</td>
<td>Minimal Disturbance to Soil.</td>
</tr>
<tr>
<td></td>
<td>Open End Steel Pipe</td>
<td>Not Recommended for Friction Piles in Coarse Granular Soils. Piles Often Have Low Driving Resistances in These Deposits Making Field Capacity Verification Difficult Resulting in Excessive Pile Lengths Installed.</td>
</tr>
</tbody>
</table>
# Pile Shape Effects on Pile Selection

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<tbody>
<tr>
<td>Tapered</td>
<td>Timber</td>
<td>Increased Densification of Soil.</td>
</tr>
<tr>
<td></td>
<td>Monotube</td>
<td>High Capacity for Short Penetration Depth in Granular Soils.</td>
</tr>
<tr>
<td></td>
<td>Tapertube</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thin Wall Shells</td>
<td></td>
</tr>
</tbody>
</table>
Questions