# Pile Driving System Components

<table>
<thead>
<tr>
<th>Primary Components:</th>
<th>Crane Components:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leads</td>
<td>Leads</td>
</tr>
<tr>
<td>Hammer</td>
<td>Hammer</td>
</tr>
<tr>
<td>Helmet</td>
<td>Helmet</td>
</tr>
<tr>
<td>Cushions</td>
<td>Cushions</td>
</tr>
<tr>
<td>Pile Gate</td>
<td>Pile Gate</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Components Required in Special Cases:</th>
<th>Template Components:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Template</td>
<td>Template</td>
</tr>
<tr>
<td>Follower</td>
<td>Follower</td>
</tr>
<tr>
<td>Jetting Equipment</td>
<td>Jetting Equipment</td>
</tr>
<tr>
<td>Drilling Equipment</td>
<td>Drilling Equipment</td>
</tr>
<tr>
<td>Spudding Equipment</td>
<td>Spudding Equipment</td>
</tr>
</tbody>
</table>
Swinging Lead

- Lead
- Hammer
- Helmet
- Pile
- Pile Gate
- Boom
- Stabbing Points
- Crane
Swinging Lead

American or Box Lead

Lead

Platform

Hammer
Swinging Lead

European or Truss Lead
**Fixed Lead**

- Lead
- Hammer
- Helmet
- Pile
- Pile Gate
- Boom
- Crane
- Spotter
Fixed Lead
Offshore Lead

- Lead
- Hammer
- Helmet
- Guide
- Pile
- Template
- Boom
- Crane
- Barge
Templates

Prefabricated or site constructed steel frame into which piles are set to hold piles in the proper position & alignment during driving.

Typically used when offshore leads or swinging leads are used over water.
Hammer Types

Drop
- Gravity

Air
- Single acting
- Double acting
- Differential acting

Diesel
- Single acting (open end)
- Double acting (closed end)

Hydraulic
- Single acting
- Double acting

Vibratory
- Standard
- Variable moment
Hammer Types

Drop
- Gravity

Air
- Single acting
- Double acting
- Differential acting

Diesel
- Single acting (open end) *Most Common*
- Double acting (closed end)

Hydraulic
- Single acting
- Double acting

Vibratory
- Standard
- Variable moment
Drop Hammers

Features

• Ram raised by crane line
• Efficiency of drop controlled by operator and system

Comments

• Low equipment cost
• Simple
• Slow operation
• Inconsistent stroke
Single Acting Air Hammers

**Features**

External compressor supplies power

Relatively heavy ram, short stroke

Stroke controlled by 1 or 2 slide bar settings: 3 ft, 3 or 5 ft, 2 or 4 ft

**Comments**

Air pressure, volume, and soil resistance can influence actual stroke by as much as 3 to 6 inches
Single-Acting Air/Steam Hammer Operation

- Piston
- Ram
- Helmet
- Pile
Single Acting Diesel Hammers

**Features**

Variable fuel settings

Relatively light ram, long stroke

Potential energy = Wh

Most common hammer type

**Comments**

Stroke depends on:
  - fuel input
  - pile stiffness
  - soil resistance
Single Acting Diesel Hammer Operation

a) Tripping

b) Fuel Injection

c) Compression - Impact
Single Acting Diesel Hammer Operation

d) Explosion

e) Exhaust

f) Scavenging
Fuel Input Control

Controlling fuel quantity can help adjust stroke height.
H [ft] = 4.01 \left( \frac{60}{\text{BPM}} \right)^2 - 0.3
Double Acting Diesel
Hydraulic Hammers

Features

External hydraulic power source

Variable and controllable stroke

Relatively heavy ram, short stroke

Increasing in usage

Comments

Most models have energy readout

Some models work underwater
Hydraulic Hammer Schematics

Single Acting

Double Acting
Observe stroke

Hydraulic Hammers
Most hydraulic hammers have built-in monitors.
Hydraulic hammer designed for low headroom operation
Vibratory hammers consist of three major components: the vibratory case, the vibratory suppressor, and the hydraulic clamp.

- The vibratory case contains eccentric weights that rotate in a vertical plane to create vibration.
- The vibration suppressor contains rubber elastomers to isolate the vibratory case from the crane line.
- The hydraulic clamp attaches the vibratory hammer to the pile.
Helmets

- Configuration and size depends upon the lead type, hammer type & size, as well as the pile type.

- One piece or base with insert models.

- Helmets should fit loosely, approximately 2 to 5 mm (0.1 to 0.2 inches) larger than pile diameter.
Helmet Components

Striker Plate

Hammer Cushion

Adapter

Helmet

Box Lead Guideway

Pile Cushion (concrete pile)
One Piece Helmets
Base Helmet with Insert
Hammer Cushions

Materials placed between the pile hammer ram and the helmet to relieve impact shock and thereby protect the hammer while at the same time transmit consistent energy to the pile
Hammer Cushions

Conbest (Phenolic fiber) and aluminum plates

Blue Nylon

Aluminum and Micarta
Hammer Cushions
H-pile Helmet and Hammer Cushion Section

Photo Courtesy of Van Komurka
Pile Cushions

• Concrete piles require a pile cushion between the helmet and the pile lead

• Typically made of plywood, hardwood, plywood & hardwood composites, or other man-made materials

• Typical thickness 4 inches (min) to 12 inches or more
Pile Cushions

Pile cushion deteriorating after 2,000 blows

Can stop driving and replace pile cushion if need to continue driving
Pile Cushions

Pile cushion thickness changes during driving

New = 8 inches

After 1400 blows = 5.5 inches
Pile Hammer Selection

• Important for the Contractor & Engineer to establish optimum hammer size for a job

• Too small a hammer may not be able to drive the pile to the required capacity

• Too large a hammer may damage the pile

• Best tool for hammer selection is a wave equation analysis.
| Installation Aids |  |
|-------------------|  |
| **Followers**     | Used to save pile length |
| **Jetting**       | Used to penetrate dense granular layers |
| **Predrilling**   | Used in cohesive soils / embankments |
| **Spudding**      | Used in debris fills |
Followers

• Is a member interposed between a pile hammer and a pile to transmit blows when the pile head is below the reach of the hammer

• Use of a follower is accompanied by a loss of energy delivered to the pile due to compression of the follower & losses in connection
Jetting

- The use of a water or air jet to facilitate pile driving by displacing parts of the soil

- Jetting is useful in driving piles through very dense granular material
Internal Pile Cleanout
Predrilling

- Soil augers or drills used where jetting is inappropriate / ineffective to
  - Penetrate obstructions, boulders, debris fills
  - Facilitate pile placement through embankments
  - Reduce ground movements

- Predrilled hole diameter 4 inches less than diagonal of square pile, or 1 inch less than diameter of round pile
Spudding

- The act of opening a hole through dense material by driving or dropping a short & strong member & then removing it

- Used as an alternate to jetting or predrilling in upper soil consisting of miscellaneous fill
Any Questions