Pile Driving Equipment

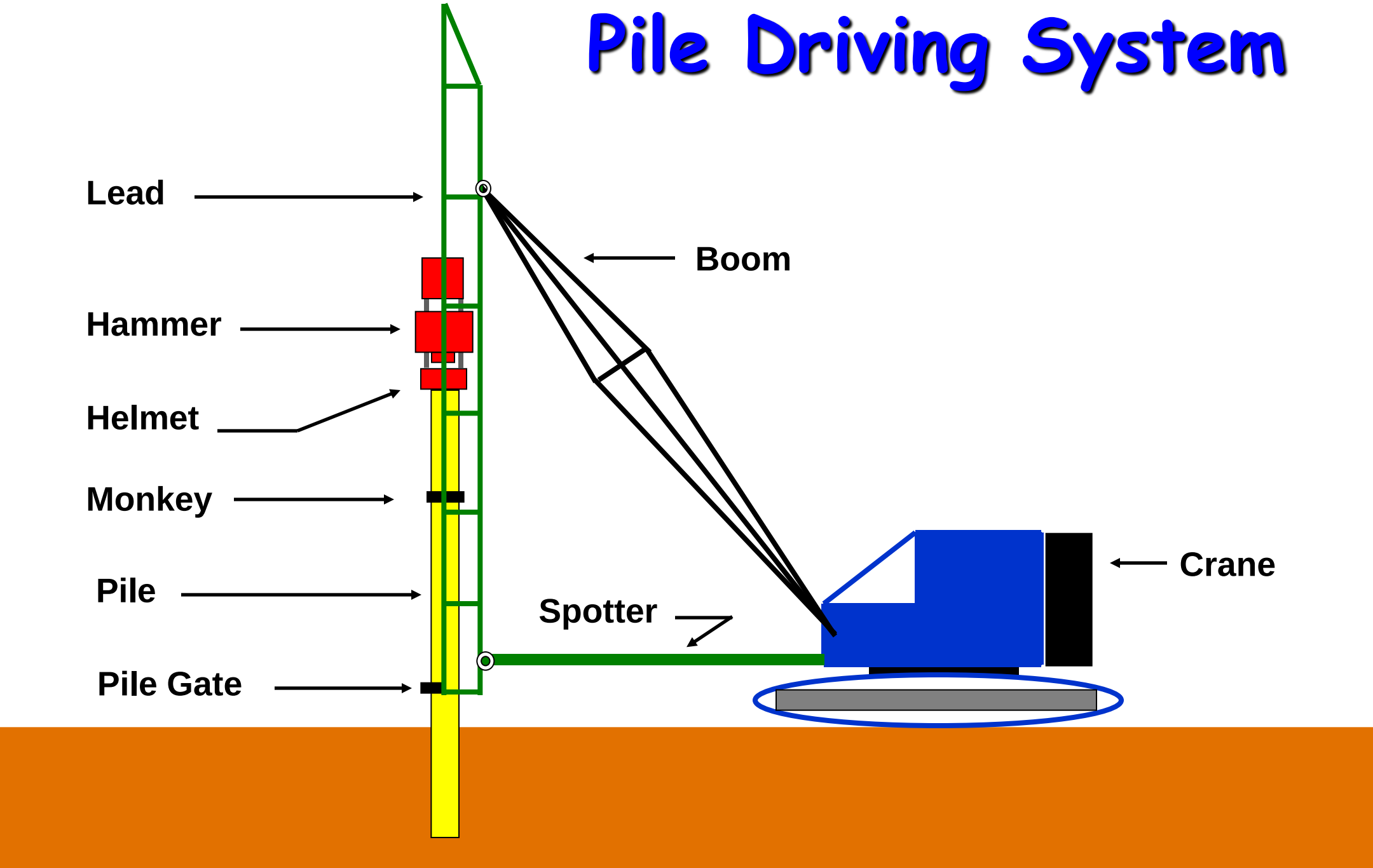
2015 PDCA Professor Driven Pile Institute

Patrick Hannigan
GRL Engineers, Inc.

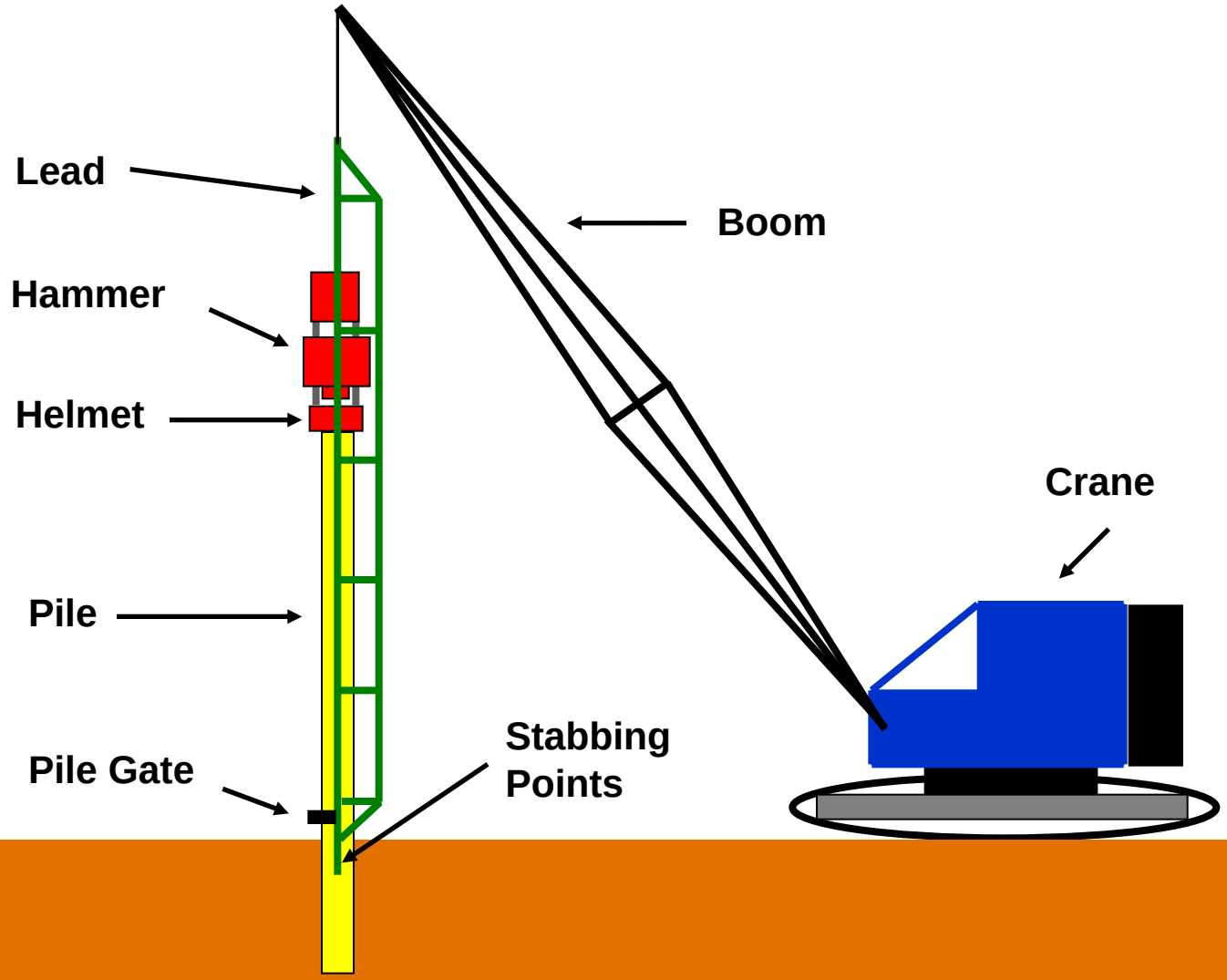
Pile Driving System Components

Primary Components:	**Crane** **Leads** **Hammer** **Helmet** **Cushions** **Pile Gate**
Components Required in Special Cases:	**Template** **Follower** **Jetting Equipment** **Drilling Equipment** **Spudding Equipment**

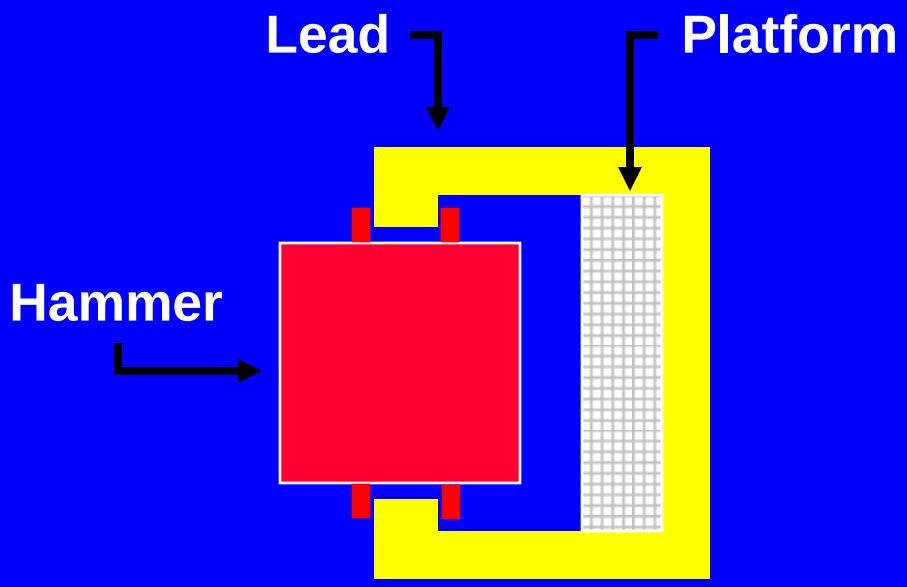
Pile Driving System



Swinging Lead

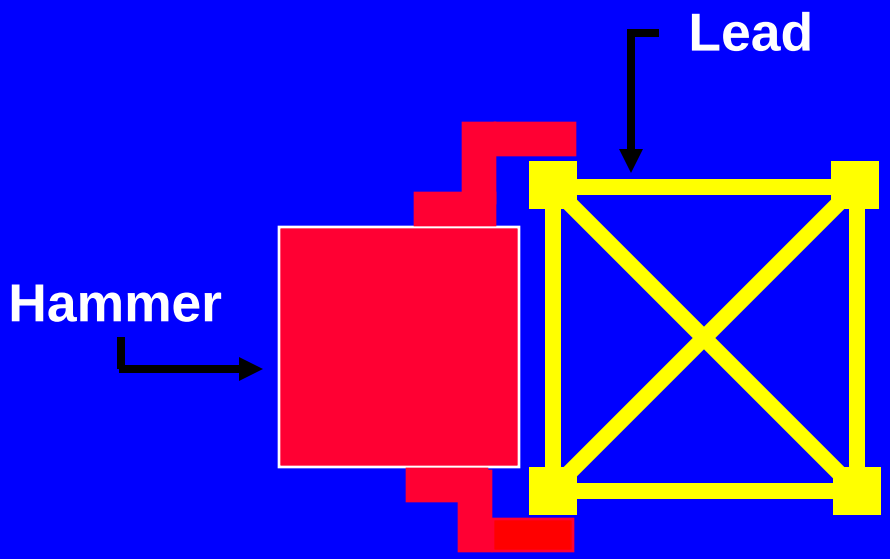


Swinging Lead



American or Box Lead

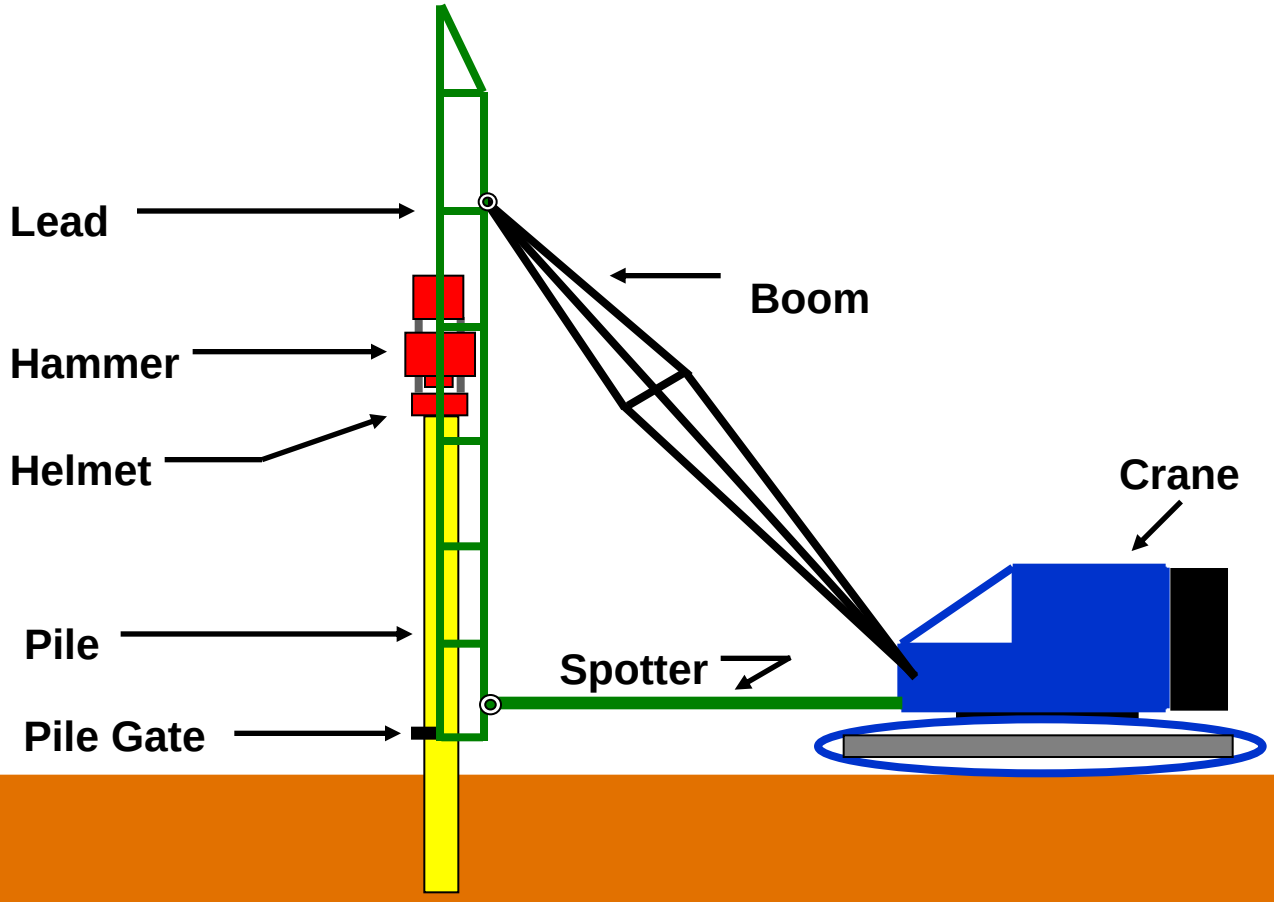
Swinging Lead



European or Truss Lead

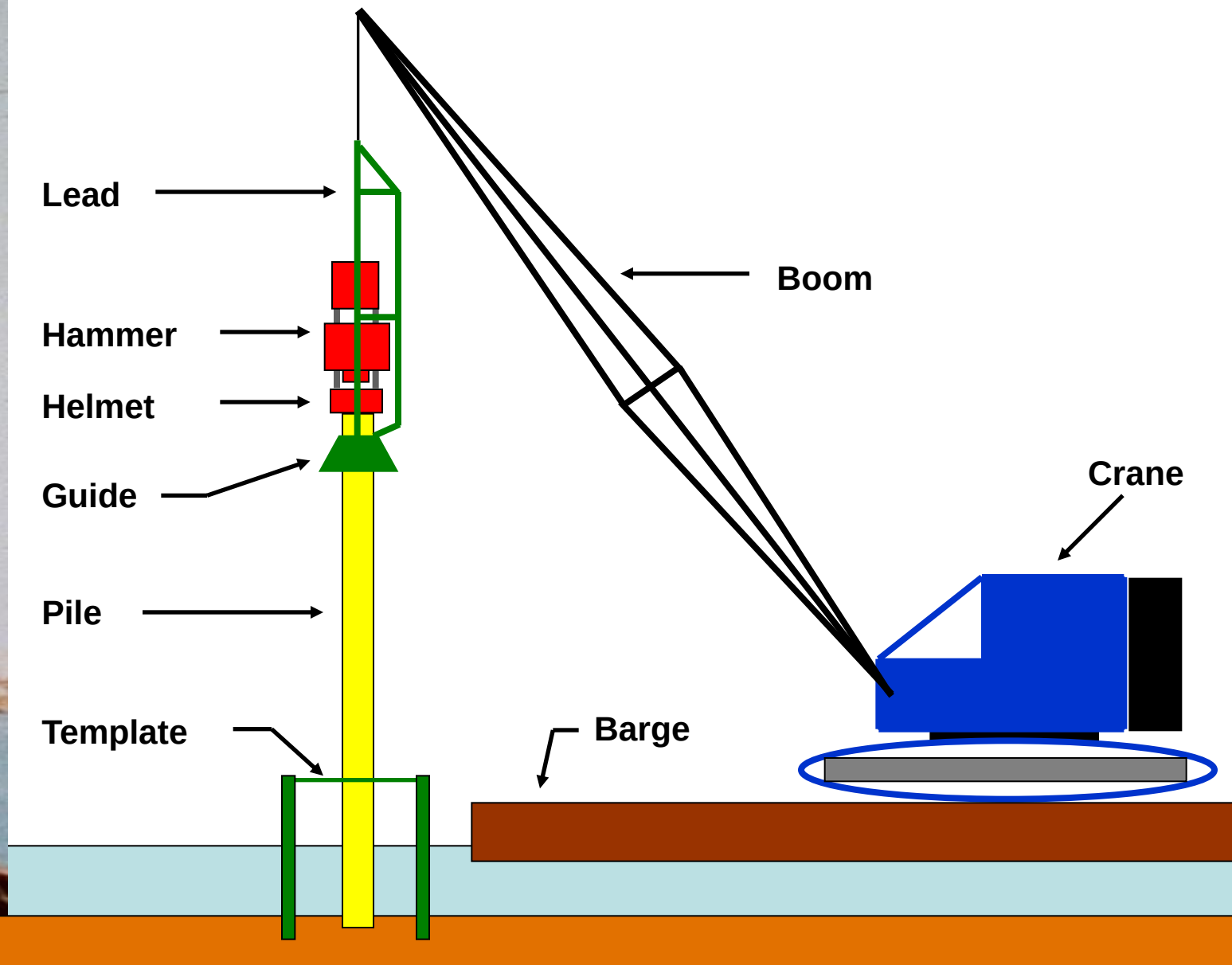
Fixed Lead


HORN
HORN


Lead
Hammer
Helmet
Pile
Pile Gate
Boom
Crane
Spotter

Fixed Lead

Offshore Lead



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.


N-54

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)** **Double acting (closed end)**	***Most Common***
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

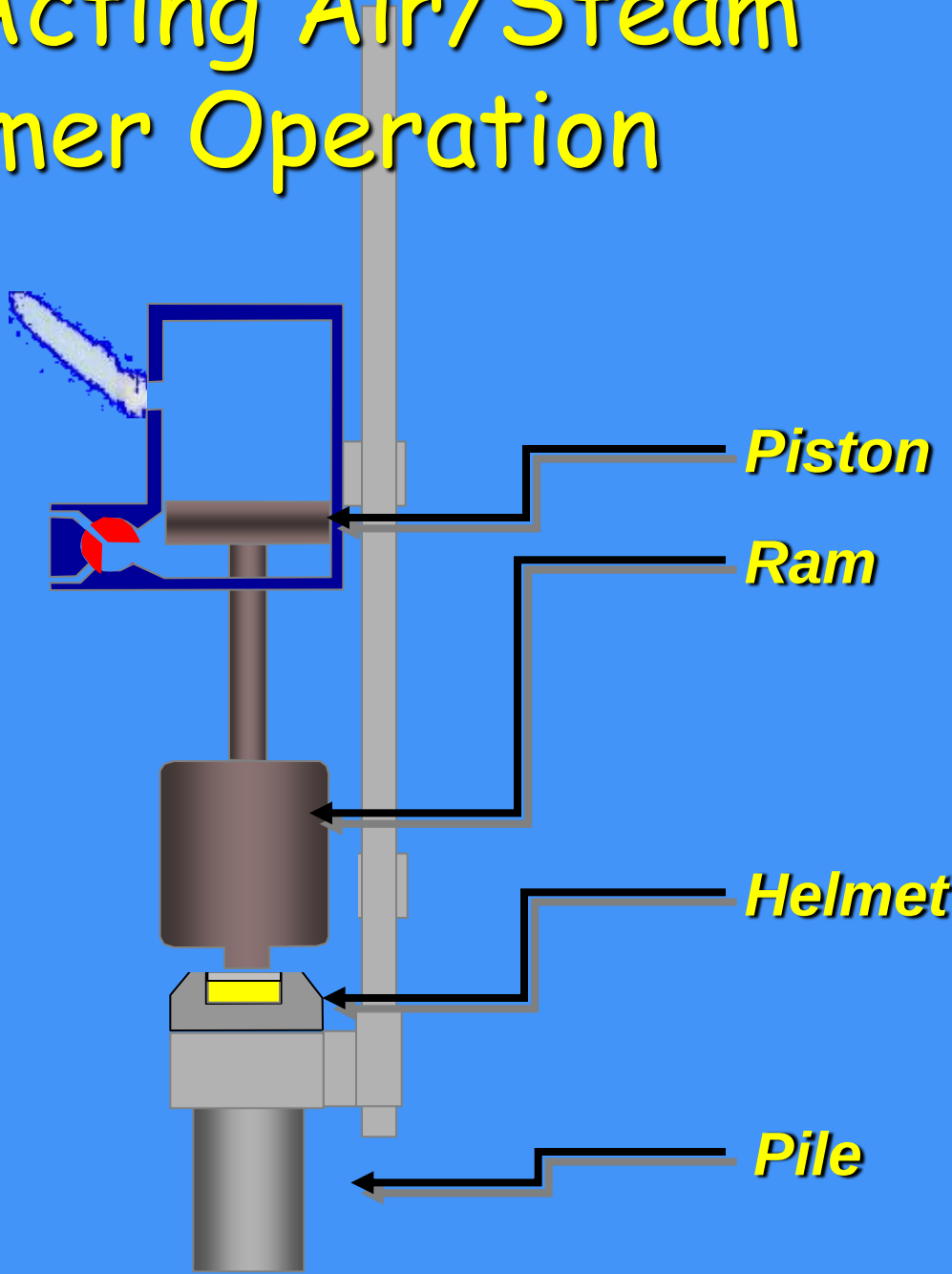
Relatively heavy ram, short stroke

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



Double Acting Air Hammer

Differential Acting Air Hammer

Single Acting Diesel Hammers

Features

Variable fuel settings

Relatively light ram, long stroke

Potential energy = Wh

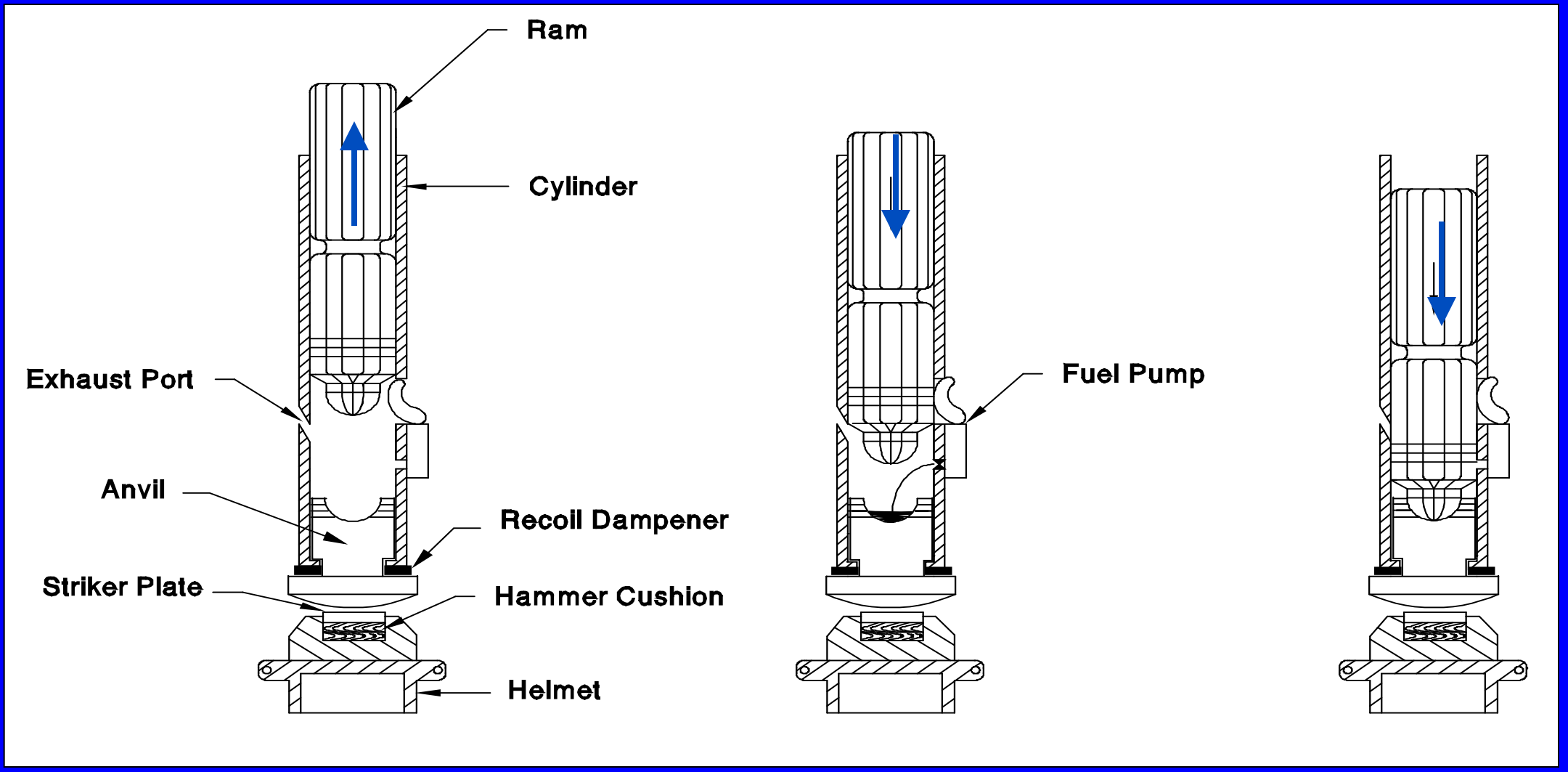
Most common hammer type

Comments

Stroke depends on:

- fuel input
- pile stiffness
- soil resistance

Single Acting Diesel Hammer Operation

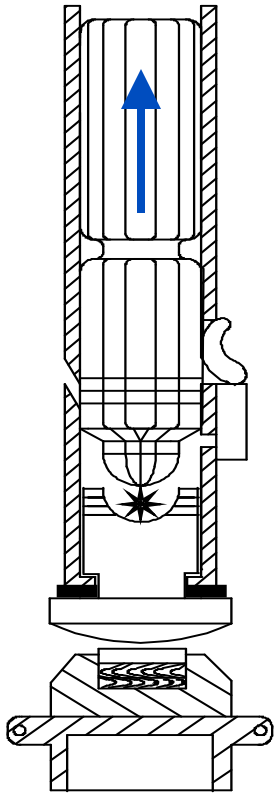


a) Tripping

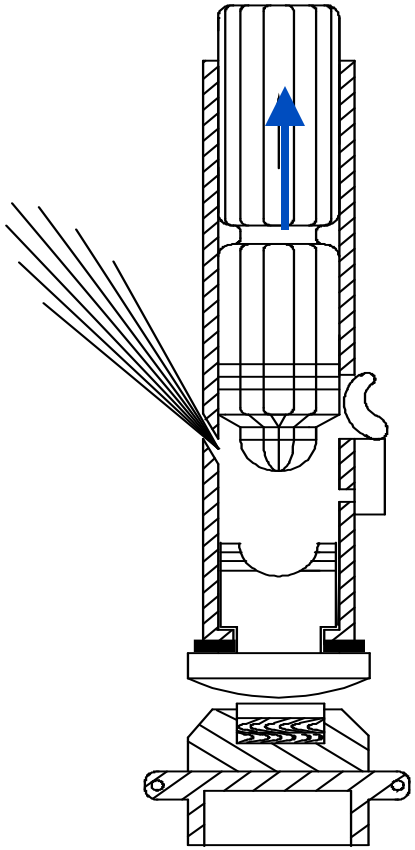
b) Fuel Injection

c) Compression - Impact

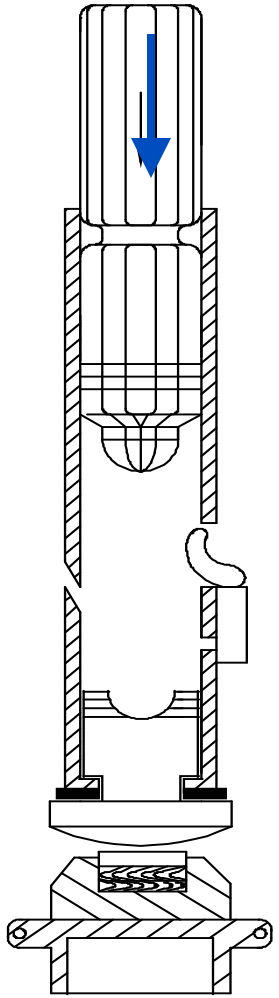
Single Acting Diesel Hammer Operation



d) Explosion



e) Exhaust



f) Scavenging

Fuel Input Control

Continuously variable

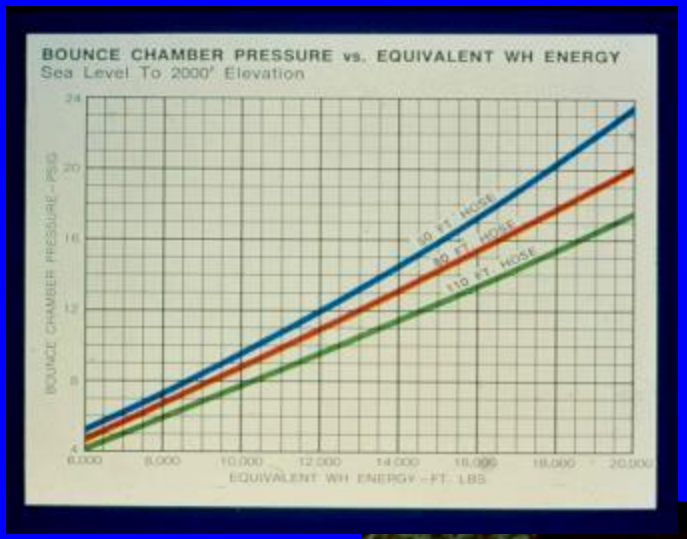
Fixed settings

Controlling fuel quantity can help adjust stroke height.

Ram - stroke

$$H\ [ft] = 4.01\ (60 / BPM)^2 - 0.3$$

Double Acting Diesel



Hydraulic Hammers

Features

External hydraulic power source

Variable and controllable stroke

Relatively heavy ram, short stroke

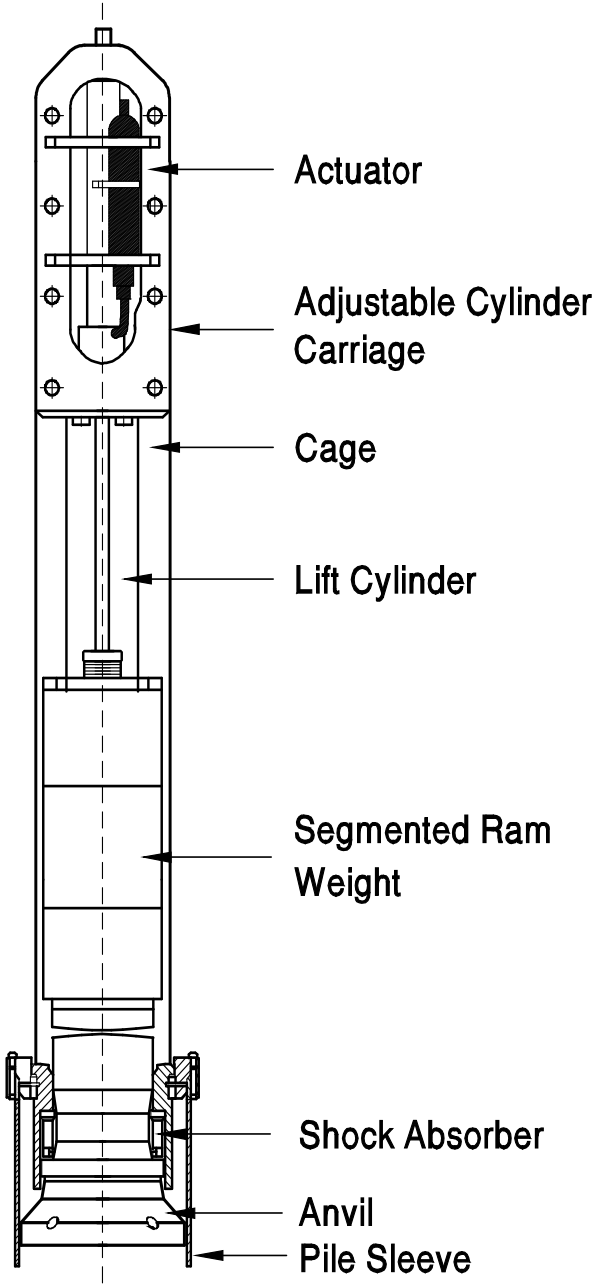
Increasing in usage

Comments

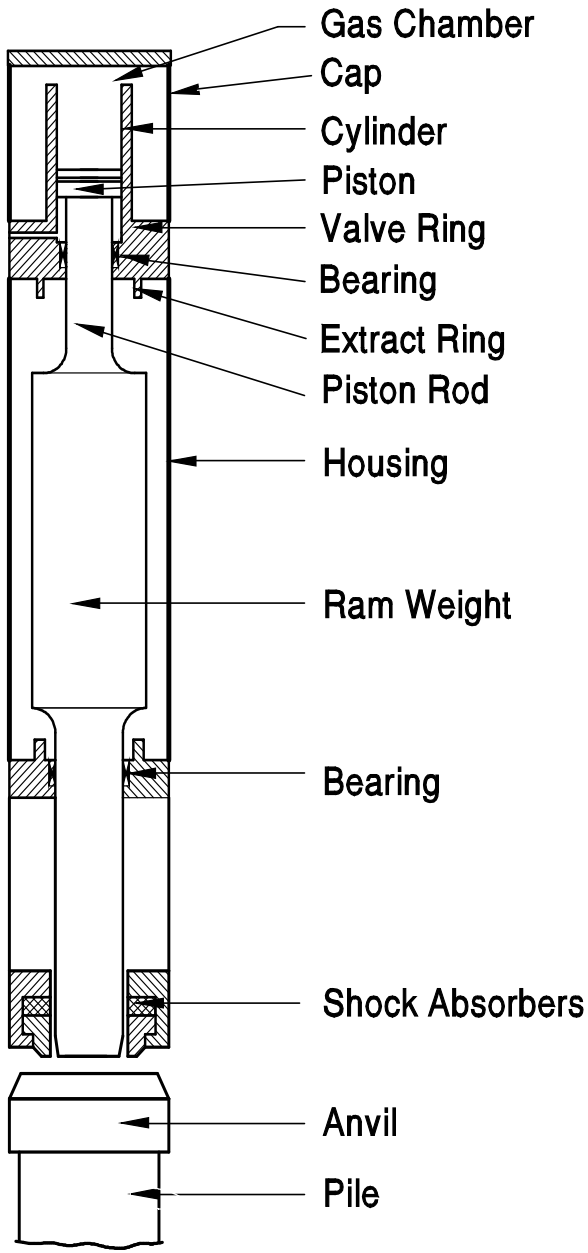
Most models have energy readout

Some models work underwater

Hydraulic Hammer Schematics



Single Acting



Double Acting

Hydraulic Hammers

Observe stroke

Most hydraulic hammers have built-in monitors

Hydraulic hammer designed for low headroom operation

Vibratory Hammers

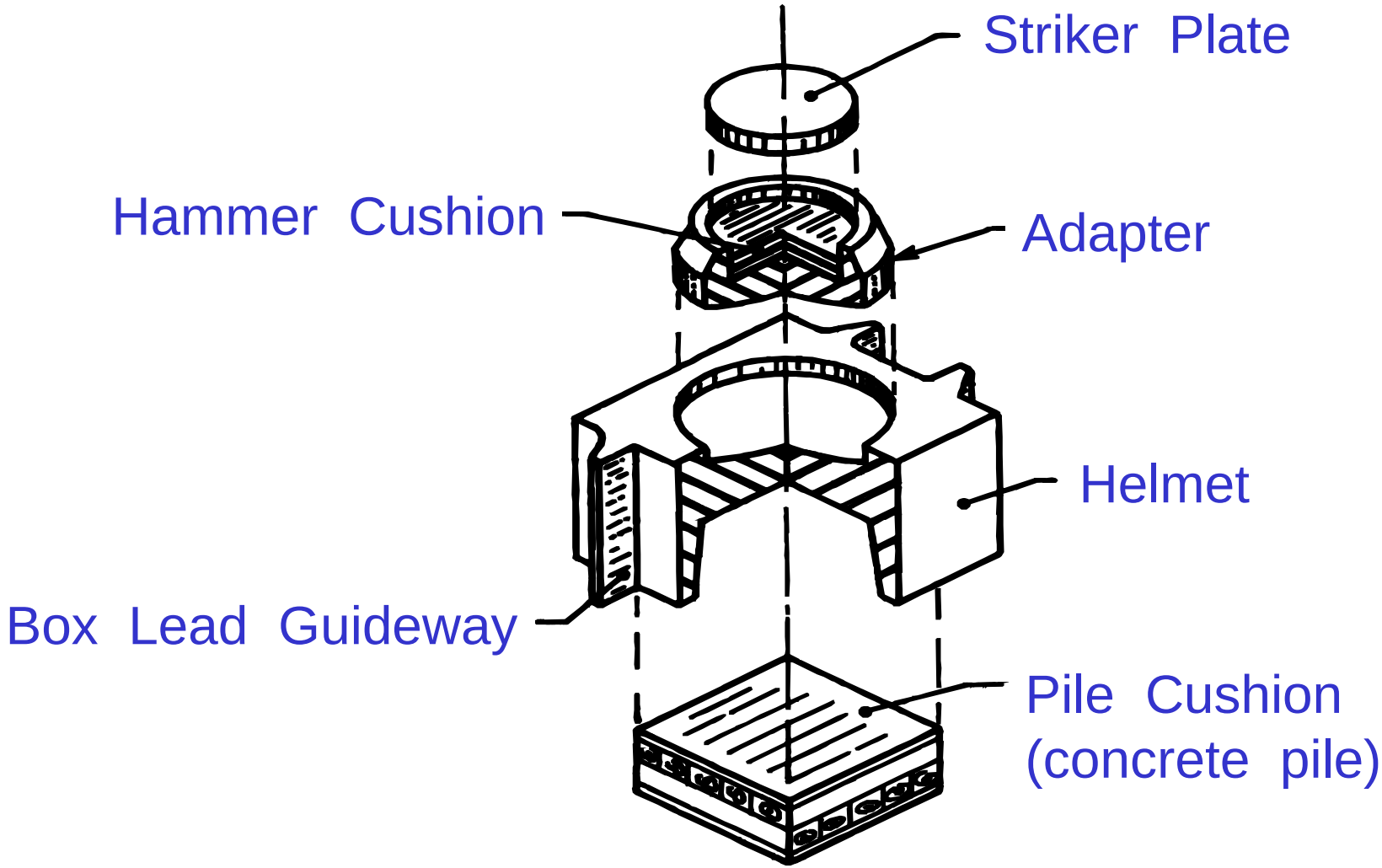
Vibratory hammers consist of three major components; the vibratory case, the vibratory suppressor, and the hydraulic clamp.

- 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



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

Blue Nylon

Conbest (Phenolic fiber)
and aluminum plates

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

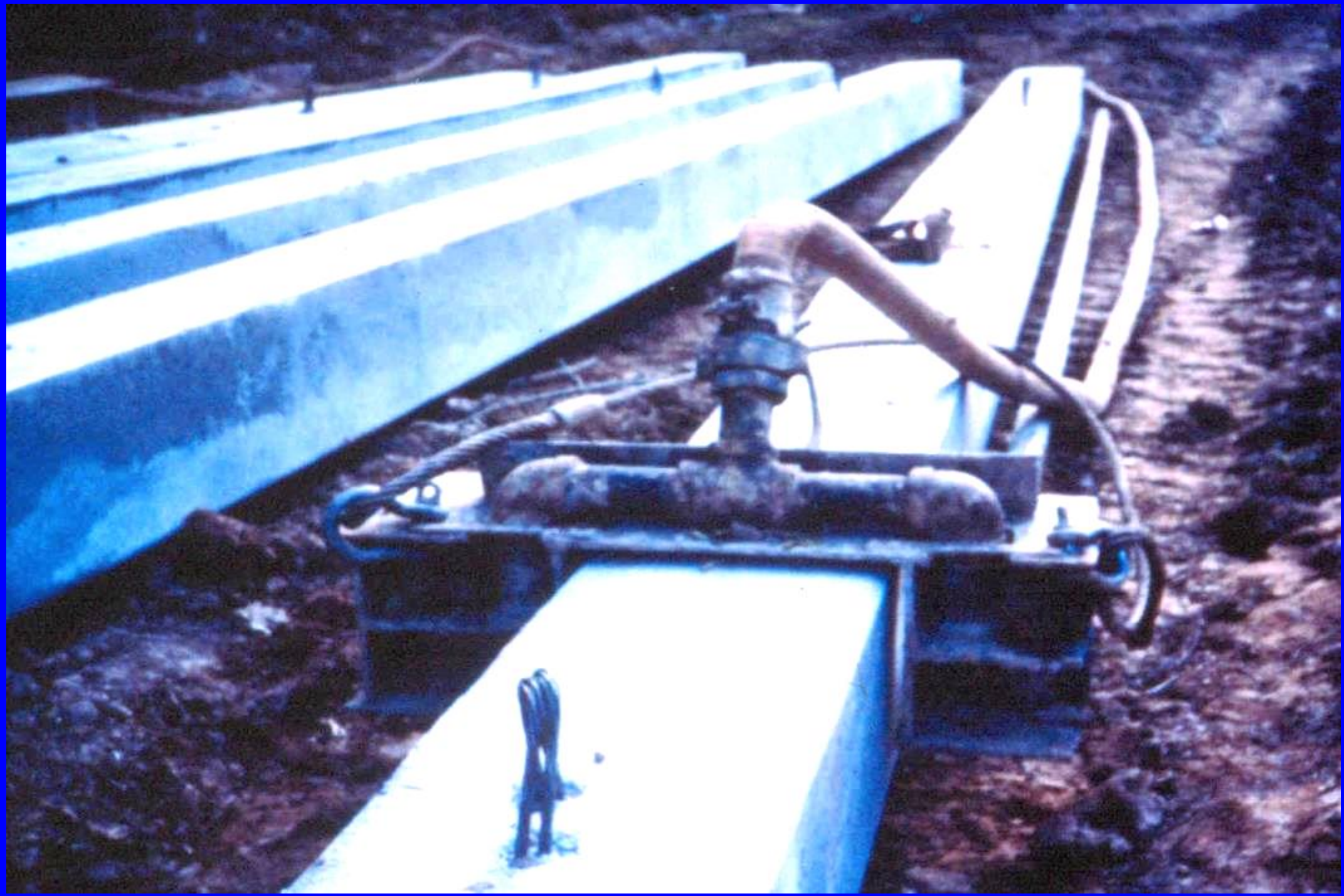
- Use of a follower is accompanied by a loss of energy delivered to the pile due to compression of the follower & losses in connection


CN
50404

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