How to Drive Steel Sheet Piles

American Piledriving Equipment, Inc.

APE Pile Driving School
What Is a Steel Sheet Pile?

Sheets of Steel plates that interconnect.
Examples
Examples
What Do They Look Like?
Various Types at a Glance

Z Sections

U Sections

Straight Web Sections
Job Examples
Section Name: Manufacturer’s Designation to identify the section. Example: PZ-27

PZ-27 means Z-Shaped with 27 pounds Per square foot.
Job Examples
Sheet Pile

Terminology: *Producer and Country of Origin*

Germany, England, Japan, USA, Korea, Luxemburg, Etc.

Arbed PU
Sheet Pile Terminology:

Shape: 4 Basic Types

1. Z-type (Z)

Arbed PU

PZ-22  PZ-27  PZ-35  PZ-40

Used for Intermediate to Deep Wall Construction
Sheet Pile Terminology:

*Shape*: 4 Basic Types

2. U-type (U)

Used For Applications Similar to Z-Piles
Sheet Pile Terminology:

Shape: 4 Basic Types

3. Flat Sheets (F)

Used to form Cellular Cofferdams
Flat Sheets
Sheet Pile Terminology:

*Shape: 4 Basic Types*

4. Arch (A)

Used for shallower wall construction. Also comes in light weights or gauges.
Two Z Shaped Steel Sheet Piles Interlocked together to form a “pair” or “double sheet”.

Description

One Sheet

Interlock area
Types of Steel Sheet Piles: Trench Shoring HOESHS

Note: No interlocks
Types of Interlocks

Ball and Socket Type

Positive Points:

- Easy to thread. Hangs up less.
- Pile Crews Desire This Type of Interlock
- Super Rugged Interlock
- Great for Repeated Use.
- Easy to Drive because Interlock displaces less soil
Types of Interlocks

Double Jaw

Positive Points:
- Proven Track Record
- Tight interlocks - Less Seepage
- Strong for repeated use.
- Good in Hard Driving Situations
- Small profile Interlocks

Single Jaw

Negative:
- Less Swing
- Hangs up more
- Holds up good but not as good as the ball and socket type interlock.
Types of Interlocks

Double Hook

Positive Points: Proven Track Record
Negative: Limited Swing
Types of Interlocks

Cold Rolled Hook and Grip

- Avoid if hard driving
- Avoid if sealing out water
Types of Interlocks

Thumb and Finger - Three Point Contact

Thumb and Finger Interlock is Used on Flat Sheet Piles. Interlock is rated by Tension Strength. Used for Cofferdams.
Types of Interlocks

Thumb and Finger - One Point Contact
Reading Sheet Pile Dimensions: **Section Area**

Cross-sectional area is listed as square inches per foot of wall.

Areas shown for flat piling are based on the single section only.
Reading Sheet Pile Dimensions: Nominal Width

Centerline from Interlock to Interlock
Reading Sheet Pile Dimensions: Weight

Weight of Square Foot of Wall
Reading Sheet Pile Dimensions:

Wall *Depth*

Distance between outboard and inboard Faces
Reading Sheet Pile Dimensions: Wall Web and Flange
Reading Sheet Pile Dimensions: 
*Moment of Inertia*

Reference Axis

Neutral axis of wall

Product of cross-sectional area and squared distance from a reference axis
Reading Sheet Pile Dimensions:

Section Modulus
What to Consider Beyond Section Modulus and Moment of Inertia.

Choosing The Right Sheet Pile for The Job Based on Driving Conditions and Dewatering Requirements.
Understanding the Difference Between Hot Rolled and Cold Formed.
Sheet Pile Terminology: Hot Rolled (HR)
Hot Rolled Steel Sheets

**Good Points:**

- Proven track record since early 1900’s
- Tight interlock for good water seal
- Proven procedures to reduce seepage based on 100 years of data
- Less interlock slop reduces tendency to lean and reduces template criteria
- Strong interlock for hard driving
- Can be made with thick (up to ¾ inch) wall for super hard driving
- Web layout superior to cold formed (for hammer energy transfer)
- More elastic at angle area (cold forming process reduces elasticity)
- Excellent for reuse due to strong interlocks
- Available for rent and rental/purchase
Hot Rolled Steel Sheets

Bad Points:

• Costs more than cold formed
• Restricted lengths 25 feet to 60’
• Lengths restricted to 5’ intervals
• Special lengths are special order
• May weigh more per foot of wall
• May not be necessary in super soft soils
Cold Formed Steel Sheet Piles Are:

Cold Formed From Steel Sheet Rolls Called Scalp or Coils
Cold Formed Steel Sheets

*Good Points:*

- Much cheaper to make than hot rolled
- Can get cut to any length and quantity
- Fast delivery and production
- 15 to 20 different shapes & thicknesses
- Good for soft driving but requires careful alignment
- Greater swing than hot rolled allows greater curves
Cold Formed Steel Sheets

Bad Points:

• Weak interlocks
• Cold formed sheet interlocks much larger than hot - harder to clamp
• Sloppy interlocks get jammed easy from soil entering
• Seepage problems
• Brittle at bent areas due to dynamic loading when cold formed
• Interlocks fail in hard soils or when striking obstacles
• Web is longer. Vibratory hammers will rip out tops
• Not good for jobs where sheets must be reused several times
• Not available for rent because interlock failures
• Requires more attention when driving
Jaws on Cold Formed Interlocks
Interlock Jamming

Hot rolled sheets have tighter tolerances that keep larger particles out. Large particles cause hitch hiking of the sheets. Hitch hiking
Dynamic Loading

Bending during cold forming loads areas.
Driving Methods - Easy Driving - pitch and Drive

- Soft Driving
- No obstacles
- Short Piles
- Smart crew
- Good sheets
- Light Vibro
Examples-
Soft Soils, Short Sheets
Pitch and drive
Driving Methods

Use at Least a Four Foot Level

Use a String Bob

: PITCH AND DRIVE
Driving Methods—other than soft

Two templates or more. Upper and Lower.
Example of Double Templates

Upper template should be substantial fraction of the pile length.
Driving Methods
Gaining or Loosing

Figure 9.3
Driving Methods-
Leaning
Stop!
Take Corrective Action.
Methods-leaning Corrections

Correction of longitudinal lean by pulling back on a wire rope.

Figure 9.1-1

In conjunction with the above method, the hammer can be placed off centre of the pair of piles towards the last driven piles.

Figure 9.1-2

When, in spite of all precautions, a lean cannot be eliminated, taper piles must be employed to correct the error.
Impact Hammers

Things to consider:

• Heavy ram, shorter stroke

• Ram weight should be 1.5 to 2 times the combined pile and cap weight

• Diesel hammer may be best choice

• Leader mounted

• Good drive cap to pile fit

• Drive in shorter steps
Impact Hammers-drive Caps
Diesel Hammer
Understanding Vibros

Suppressor

Gearbox

Clamp Device
Vibro Suppressor - rubber Springs

Isolates vibro action from crane line.
Vibro of Rotating Eccentrics

Paired Eccentrics
Eccentric
# Four Strokes of the Eccentric

<table>
<thead>
<tr>
<th>Stroke</th>
<th>Description</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 work</td>
<td>Forces the vibro and the casing downward</td>
<td><img src="image1.png" alt="Image" /></td>
</tr>
<tr>
<td>2</td>
<td>Nothing happens. Each eccentric cancels other out.</td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
<tr>
<td>3 work</td>
<td>Both eccentrics for vibro and casing upward</td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
<tr>
<td>4</td>
<td>Nothing happens. Each eccentric cancels other out.</td>
<td><img src="image4.png" alt="Image" /></td>
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Vibro-Driver/Extractors

Eccentric moment

Eccentric moment = distance between the center of rotation and the center of gravity \times\ the total mass of the eccentric.
Example of calculating eccentric moment of one eccentric:

Equation:

Distance between Center of Rotation and Center of Gravity Multiplied by The Mass

2 times 500 equals: 1,000 inch pounds
Eccentric moment of a vibro is measurement of all eccentrics combined.

If each eccentric has 1,000 in-lbs then the vibro has a total of 2,000 in-lbs.
Some vibros have many small eccentrics to get a large total inch pounds while others have less eccentrics that are bigger.

More vibrating weight
Less amplitude

Less vibrating weight
More amplitude
Smaller Weights Means More Bearings, Shafts, Gears.

More parts

Less parts
Amplitude

\[ A = 2 \times M_t \]

\[ M_t = \text{Eccentric Moment in inch pounds} \]

\[ M_v = \text{Total Vibrating Weight} \]

\[ A = \text{Amplitude in inches} \]

Vibrating weight: \( M_v \)

The vibrating weight is the sum of all the weights of the vibrating mass.

B: Dynamic weight (vibrating mass)

C: Clamping device including all plates or clamps

D: Pile weight

Suppressor does not vibrate.
Non-vibrating mass.
The hammer on the left has the same eccentric moment but less amplitude because the vibrating mass is heavier.
Amplitude will decrease with increase of pile weight. Big piles need bigger vibros to offset loss of amplitude.
Amplitude will decrease with increase of:

- Pile weight
- Soil resistance
- Weights, gears, shafts, hoses, motors
- Extra clamp attachments
- Anything that increases vibrating mass.

\[
\text{Amplitude} = \frac{2 \times EM}{VM}
\]

EM: Eccentric Moment
VM: Vibrating Mass
Frequency (Vibrations Per Minute) or (Cycles Per Minute)

Frequency is the rotational speed of the vibro eccentrics.
Drive Force (Dynamic Force)

Drive Force = \frac{\text{Eccentric Moment} \times 0.0142 \times \text{Frequency}^2}{1,000,000}

Example:

Moment: 4400 in-lb.
Frequency: 1600 Cycles per minute

\frac{4400 \times 0.0142 \times 1600 \times 1600}{1,000,000} = 159.94 \text{ Tons}

Drive Force
How Frequency Matters

1100 cpm

4000 in-lb.

4400 x 0.0142 x 1100 x 1100

1,000,000 = 75 tons

1600 cpm

159.94 =

4400 x 0.0142 x 1600 x 1600

1,000,000
Higher Frequency Dramatically Increases Drive Force
Because Frequency is squared.

\[
\begin{align*}
5208 \text{ in-lbs} & \times 0.0142 \times 1100 \times 1100 = \frac{89 \text{ tons}}{1,000,000} \\
4400 \text{ in-lbs} & \times 0.0142 \times 1600 \times 1600 = \frac{159.94}{1,000,000}
\end{align*}
\]
Vibro Jaws

Moveable Jaw

Fixed Jaw
Vibro Clamps - basic Rules

- Wait for hammer to come to speed
- Clamp in center
- Clamp always in line with pile axis
- Avoid clamping on interlocks
- All of teeth in work
- Watch jaws and interlocks for heat
- Do not pull or drive vibro until speed is reached
- Do not open until vibro stops moving
- Melting interlocks means jaws are also taking a beating
Jaws - watch the Interlocks
Do Not Crush Interlocks

Special deeper Jaws
Model 400 on Sheets

Hard Driving Required
The Use Of Super Vibro.

Sheet piles for Air Force missile silos.
Pile Buck Tools for Driving Sheets

This tool holds leading sheet pile to lower guide.
Stab Cat

OPEN WHEELS AND JAWS - REMOVE BOTH COUPONS AND TURN COUPONS UP-SIDE DOWN - RE-INSTALL - TIGHTEN WHEELS AND JAWS - THE INTERLOCK WILL BE "PITCHED" LEFT - LOosen RIGHT HAND JAW CRANK AND TIGHTEN LEFT HAND JAW CRANK UNTIL 12" COUPON (SUSPENDED SHEET) INTERLOCK IS EXACTLY IN CENTER OF RECEIVING INTERLOCK - TIGHTEN BOTH JAW HAND CRANKS, KEEPING INTERLOCK CENTERED - LOOSEN SET SCREW IN LEFT HAND LOCKING COLLAR - SLIDE LOCKING COLLAR AGAINST JAW POST AND RE-TIGHTEN SET SCREW.

SET UP IS FOR SINGLE OR DOUBLE SHEETS