A vibro is a tool that, when attached to a pile, shakes it up and down in a vertical motion for the purpose of installing or removing it from the soil.
Vibratory Pile Driver/Extractors In Action!
Example:

Vibrating H-Beams
Example: Vibrating Casings
Example: Vibrating Plastic Sheets
Example: Pulling Concrete Piles
Example: Pulling Piles
Example: Power Pole Foundations
Example: Excavator Mounted
Example: Vibrating Large Caissons
Example: Vibrating Wick Drains
Example: Vibrating Sheet Piles
Example: Big Concrete Caissons
Understanding The Components Of a Vibratory Pile Driver/Extractor
Vibratory Pile Drivers/Extractors

Suppressor Housing

Gearbox

Clamp Attachment
How Does A Vibratory Pile Driver/Extractor Work?
What’s Inside The Gearbox
Eccentrics: The Heart of the Vibro

All Vibratory Pile Driver/Extractors Have Rotating Eccentrics.

This Photo Shows One Example Of An Eccentric And Gear.
A look inside a vibro
Eccentric
Two Eccentrics

All Vibratory Pile Driver Extractors Have At Least Two Paired Eccentrics
Two Eccentrics
Four Eccentrics
Six Eccentrics
Four strokes of the paired eccentrics

1 work

Forces the vibro and the casing downward

2 Cancel

Nothing happens. Each eccentric cancels other out.

3 work

Both eccentrics for vibro and casing upward

4 Cancel

Nothing happens. Each eccentric cancels other out.
History
Russia’s Barken
French/Japan
MKT: Hyd
H&M
ICE: Rubber springs
APE- Two stage, rifle bore, etc.
Variable 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.

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

\[ A = 2 \times Mt \]

\[ Mt = \text{Eccentric Moment in inch pounds} \]
\[ Mv = \text{Total Vibrating Weight} \]
\[ A = \text{Amplitude in inches} \]

Vibrating weight: \( Mv \)

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

- B: Gear Box (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.

4000 in-lbs.
Amplitude will decrease with increase of:

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

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 squared}}{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}
How Frequency Matters

1100 cpm

4400 x 0.0142 x 1100 x 1100

1,000,000

= 75 tons

1600 cpm

4400 x 0.0142 x 1600 x 1600

1,000,000

159.94
Higher frequency dramatically increases drive force because frequency is squared.

\[
\frac{5208 \times 0.0142 \times 1100 \times 1100}{1,000,000} = \frac{4400 \times 0.0142 \times 1600 \times 1600}{1,000,000} = 89 \text{ tons} \quad 159.94 = \]

\[
5208 \times 0.0142 \times 1100 \times 1100 \quad 4400 \times 0.0142 \times 1600 \times 1600
\]

\[
1,000,000 \quad 1,000,000
\]
Understanding Vibro Suppressors

Old Technology

New Technology

Much more capacity with no vibration to the crane line.
A Centerline Clamp has two jaws that are controlled by giant gears to keep the pile always in the center. Used to drive or extract pipe, wood, or concrete piles. It is also used to extract concrete filled shell piles.
Centerline Clamp Pulling Concrete
Extracting Concrete Piles
90 degree plate
Clamp Extension
Extending caisson clamps down to clear rebar cage.
Duel guiding, full six inch slide, check valve clamp, easy to read
Understanding the Power Unit.
Skid

Quick disconnects

Hydraulic tank

Inspection cover

Power Unit view on quick disconnect side.
View of power unit from ladder side.
View of hydraulic tank level gauges and return filter.
Spare tank oil valve. Do not open unless you need oil in lower tank. Be careful not to over fill main tank or excess oil will come out breather.

Spare tank ¼ turn valve.
Float switch
Quick disconnects
Clamp

Case Drain

Forward/Reverse with caps and plugs.

Fuel Tank clean out plug

Quick disconnects
Cooling pump with piggy back clamp pump.
Cooling system schematic
View of clamp and its components

Clamp Housing

Fixed jaw  Moveable jaw

Cylinder

Open  Close
Clamp hydraulic circuit
Clamp disconnects with caps and plugs attached.
Clamp Manifold

Clamp open gauge hose

Clamp close gauge hose

Main Clamp Relief Valve

To adjust, loosen lock nut and turn “in” to increase relief pressure or turn “out” to decrease pressure.

Note: Normal setting is 4800.

Solenoid Valve

Safety Check

Pressure Switch

Note: Turn slot with screw driver to adjust.

For driving wood piles or other soft piles like concrete, you may need to lower the pressure.
Clamp Manifold
Clamp relief valve
Pressure switch
Adjusting screw for setting clamp pressure.
Solenoid Valve

Note:
Set all valves with no disconnects connected.
When setting clamp pressure, this pressure switch must be set 300 psi below the relief valve. You must first set the main relief valve to 4800 psi and then set the pressure switch.
Power unit pump hoses.

Pump pressure hoses leading to main manifold.

Power unit pump hoses.
Power unit main pumps.
Power unit hydraulic schematic for vibro motors.
Clamp and Drive animation.
Main drive forward and reverse QD’s
Case Drain QD
Drive manifold
Control panel showing how power cables for solenoids can be removed quickly.
Controls for power unit

- Emergency stop
- Vibro start/stop/reverse
- Clamp open/close/off
- Engine throttle
Remote pendant control box

- **Stop**
- **Engine throttle**
- **Clamp open/off/close**
- **Drive forward/reverse**
Control panel
Shut down warning indicators

- Oil
- Coolant
- Hyd
- Hyd
- Press
- Temp
- Level
- Diagnostic

[Image of warning indicators]
Engine Hour Meter
Hour Meter
Volt Meter
Reads water temp and is also shut down switch.

Adjust here.
Pops out when something is wrong.
Starts diesel engine.

You must hold in the fault switch to override the engine oil pressure switch until oil pressure is reached.

Push and hold until oil pressure is normal, then let go.
You must push this button in and then watch oil pressure gauge until it goes up past switch setting.
Engine Oil Pressure Gauge is also a switch that is adjustable with a small Allen wrench.
Controls
governor
raise
lower
engine
RPM
Turn to “pendant” when you are using the 50 foot hand held pendant. Switch to “local” if you are going to run the power unit off the control panel.
Turn to forward to vibrate.

Turn to reverse if you are using a drill.

Note: Do not use reverse at any time to run the vibro. Vibro drives and extracts in forward position only!
Turn to “open” to open jaws.

Turn to “close” to close jaws. Keep on “close” and make sure light comes on.

Switch is also a light. Light comes on when jaw pressure raises high enough to engage the pressure switch.
Understanding power unit gauges
Hydraulic oil temp gauge and switch. Switch shuts engine down when oil temp passes setting. Set the maximum temp using a small allen wrench. Usually set at about 190 degrees.
Clamp Close gauge reads hydraulic pressure on the clamp jaws.
Clamp open reads the actual relief valve setting on the clamp manifold. You are reading the safety relief valve setting.

**Note:** This is not the valve you change if you are wishing to lower pressure on the clamp. Use the pressure switch for that. This gauge reads your pressure setting and it should be at 4800 pounds per square inch.

**Note:** Always check this first. With clamp lines disconnected, turn the clamp switch and hold it to open and read the gauge. It should be at 4800 psi.
Drive forward is used to turn the vibro eccentrics. Turn to forward for driving and extracting. Note: Only use the reverse when the power unit is operating a drill and you need to reverse the rotation of that drill. Vibro will not work in reverse.
Hydraulic oil filter gauge tells you if the oil filter needs changing.

Change filter if you pass 50 pounds per square inch. Note: May read high if oil is cold. Wait until oil is 100 degrees.
Things to do before starting the engine
Radiator Cap - Check level.
Check engine oil level
Check V-belts
Check hydraulic oil level
Check pump drive gear box oil level
Check diesel fuel level
To Start:

Push and hold while turning the start switch. Holding the fault button over rides the engine oil pressure shut down switch. Once oil pressure is reached, you can let go of the button.
Turn to “pendant” when you are using the 50 foot hand held pendant. Switch to “local” if you are going to run the power unit off the control panel.
Unit will not start if drive forward switch is turned on.
Controls for power unit

- Emergency stop
- Vibro start/stop/reverse
- Clamp open/close/off
- Engine throttle
Control panel on power unit

Same controls as on hand held pendant serve as back up controls if hand held pendant is damaged. Gauges show all pressures.
Vibro in action
Vibros in action
Vibros in action
Vibros in action
Vibros in action
Vibros in action
Tandem vibro with tandem power units
Clamp attachments - two clamps
Casing clamps- two clamps Japanese style
Two clamp system-French style
Adjusting clamps
Rotating all thread raises or lowers wedge distance
Nut is welded. Always look at wedges while turning to make sure you are turning the right direction.
Wedges must be greased. If wedges are not tight the vibro will not put energy into the casing.
Attachments: Four Clamp
Attachments: Concrete
Attachments
concrete piles
Center pull clamp has two jaws that are gear timed to make sure pile is centered. Designed for pipe up to 24”, concrete piles, & wood piles.
Pile failures
Casing was too light in this situation

Pile or casing failures
Belly bands are added to the top and sometimes to the bottom of the casing to solve the following problems:

Keep jaws from tearing off top of casing

Prevent flexing of the casing which causes unwanted vibrations to adjacent soil and buildings.

Flexing also takes away energy from the vibro that needs to be at the tip.
Vibros underwater
Underwater operations
Underwater operations