Vibratory hammer technology explained

What is a vibratory hammer?

A "vibratory hammer" is a tool used to drive piles in or out of the ground for building marine docks, bridges, buildings, roads, rail, walls, and many other types of foundations. Traditional pile drivers are very loud and use a large weight to strike the pile. Vibratory hammers however are very quiet and have many advantages. A few advantages of vibratory hammers are that they can drive piles much more quickly, extract old piles out of the ground, can be used underwater, are light weight, protect the environment (especially animal life), can be used in close proximity to residential areas without noise complaints, and are small and easy to ship. .

How does a vibratory hammer work?

Unlike traditional pile driving equipment that uses a large weight or ram to strike a pile, vibratory hammers use spinning counter-weights to create vibration to the pile, which allows it to "cut" soil into the ground. If you have ever put a nail in the wall with a hammer then you can understand how a traditional pile driver works. If you have ever used an electric knife to cut through meat than you can imagine how a vibratory hammer works. The high-speed vibration causes the soil to actually "liquify" and the pile will slip into the ground almost effortlessly. Many would describe using a vibratory hammer like using a hot knife to cut through butter or tofu. When watching a vibratory hammer work for the first time it may seem quite strange to see the pile going into the ground so quickly. Using traditional pile drivers a 30m long pile could take up to an hour to drive all the way in the ground, using a vibratory hammer that same pile can be driven in 10 minutes or less depending on soil conditions.

What is the difference between an electric and a hydraulic vibratory hammer?

In the market today there are two main types of vibratory hammers - electric and hydraulic. Electric hammers and hydraulic hammers have many differences but in a very basic sense they similar traits. Both electric and hydraulic hammer use a “power unit” that powers the hammer, both have clamps allowing the hammer to connect to the pile, both use wires or hoses to connect the hammer to the power unit. Other than a few basic traits however they are two very different animals.

A simple explanation of the difference starts like this: Electric vibratory hammers use a large electric motor on top of the hammer to spin the counter-weights. To power the electric motor a large power unit with a diesel engine will turn a generator giving enough power to the motors. Hydraulic hammers however use hydraulic motors to spin the counter-weights. To power the hydraulic motors a large power unit with a diesel engine turns hydraulic pumps, which flow oil out to the motors and back.

The basic difference seems simple enough, but the real difference is the advantages of using hydraulic compared to electric. The number one main advantage is that hydraulic hammers are far more powerful than electric hammers and are half the weight. The other main advantage is that they can spin at a much faster speed than electric hammers. Research has shown that the higher the vibration speed the less vibration will travel through the soil to surrounding buildings. This means that you can drive a new foundation next to an older building and vibrate loose its pre-existing foundation. Electric vibratory hammers spin slow compared to hydraulic, which causes an earthquake effect around the pile.

Content and pictures from APE Vibro, ThyssenKrupp/Müller and PVE-Holland

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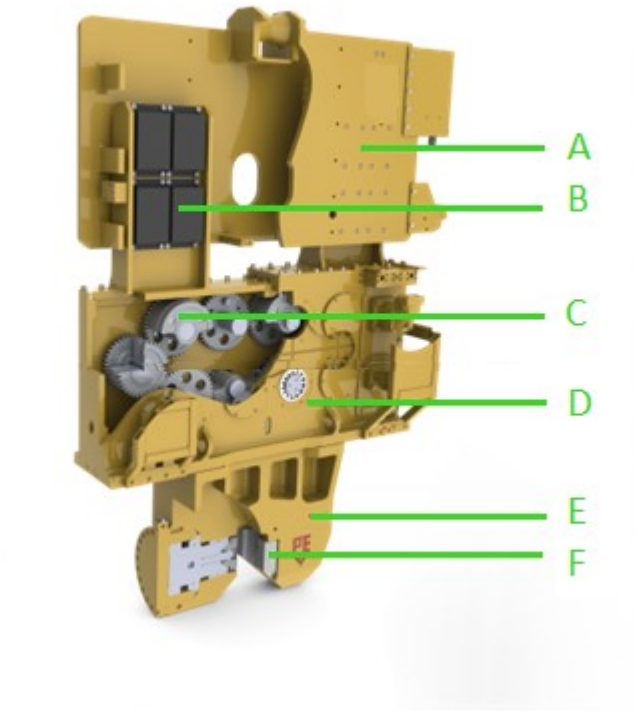
The design of a vibratory hammer



A suppressor
B elastomers
C excenters
D vibratrion case (gearbox / carter)
E clamp
F jaws

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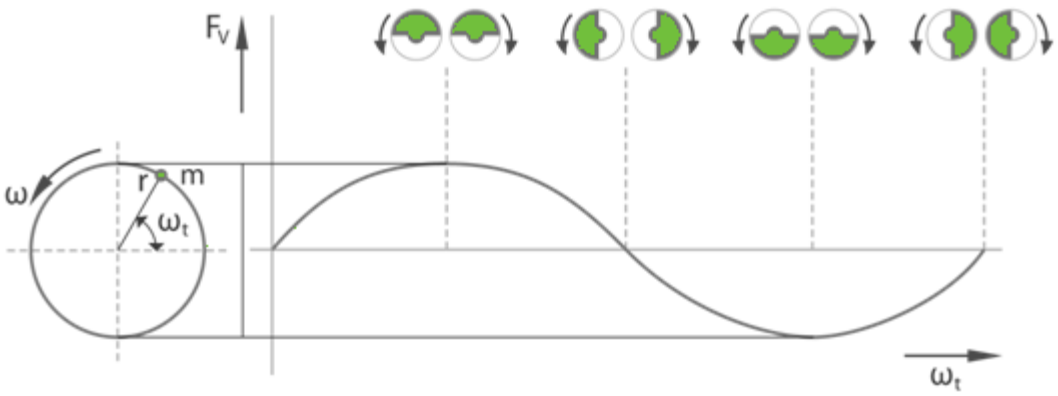
Vibration case

The vibration case has two pairwise installed eccentric weights that rotate in a vertical plane to create vibration. In doing so, they generate each a centrifugal force. When two unbalanced eccentrics maintaining the same moment are rotated in opposite directions, vertical (up and down) vibration of constant cycle is produced.



F_v	vertical force	**r**	rotations per minute
w	angular frequency	**w_t**	angular frequency π-radian
m	mass		

The weights are driven by hydraulic engines. The eccentrics are gear connected to maintain proper synchronisation. The eccentric shafts are mounted in heavy-duty roller bearings. The maximum capacity of the engines is hydraulically limited.

Suppressor

The extraction head contains rubber elements (elastomers) to isolate vibrations from the vibration case to the crane or pile driving rig. The tare weight of the suppressor housing advances the driving speed.

Clamp

As an option, the hydraulic clamp contains two gripping jaws, one fixed and one moveable. A cylinder, integrated in the clamp body, operates the moveable jaw and has a pilot operating check valve that keeps the cylinder under pressure in case of hose damage. The clamp is operated hydraulically.

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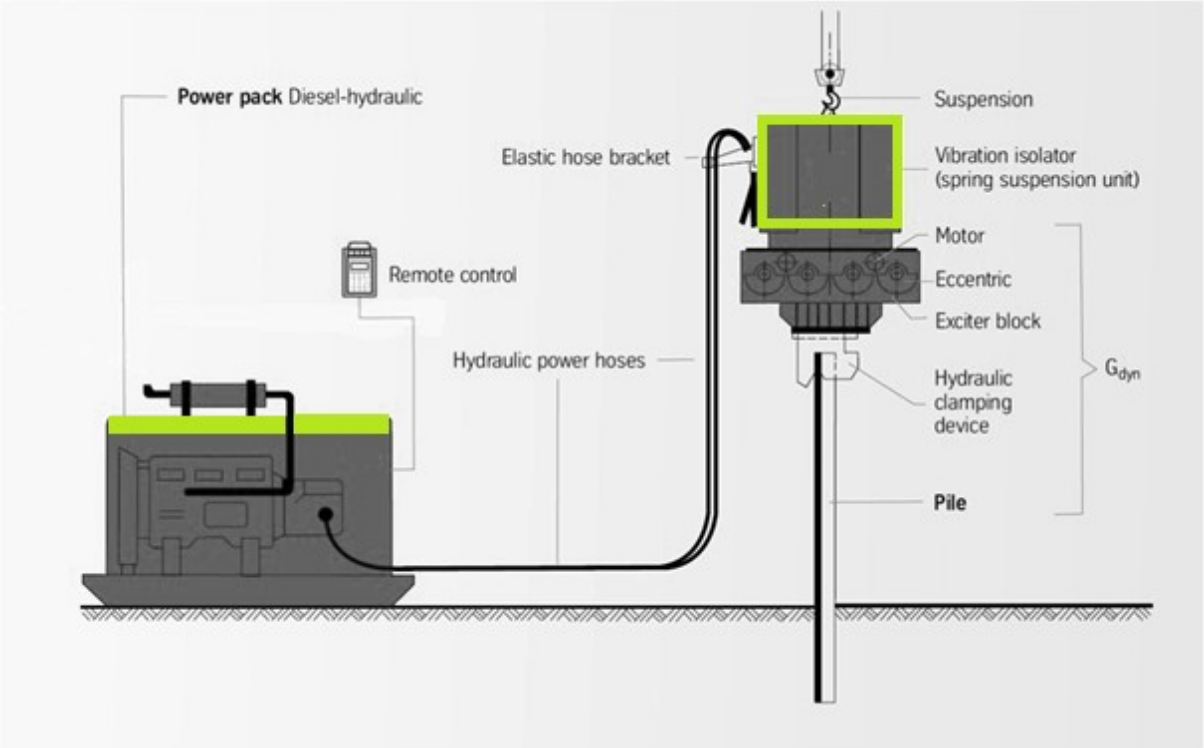
The setup of a hydraulic system

The classic pile driving setup includes a power pack and a vibratory hammer. The heart of any vibratory hammer is the exciter block, containing pairs of counter-rotating eccentrics running in heavy-duty special bearings. Arranged at the top of the machine is a spring yoke, whose job is to absorb the vibrations caused by the exciter block before they can reach the carrier.
The power pack is driven by a diesel engine and supplies the oil flow to the vibrator via hydraulic pumps.This ensures that the vibrator is supplied with energy to drive the piling into the soil.



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