

Pile Driving System

Field of the Invention

The invention can be utilized, for example, as a device for crawler-mounted pile driving machines, excavators, cranes, and other machinery suitable for pile driving, which installs piles into the ground to stabilize construction foundations. The mentioned solutions are applicable in devices used, for example, in civil and marine construction. The invention is powered by the aforementioned machines or another hydraulic power unit, which could be a separate hydraulic system. The invention installs objects that are driven into the ground or seabed, such as concrete piles, steel pipe piles, steel profiles, and sheet pile structures.

Prior Art

The generally known technique comprises a pile driving machine equipped with an impact device, where the hydraulic power requirement is designed according to a traditional impact device that hydraulically moves a single impact hammer to create the installation impact.

The generally known technique does not focus on solving the problem where the impact device comprises two independently operating hydraulic impact hammers, for which the required hydraulic power is insufficient.

The generally known technique does not address the problem where the impact device comprises two independently operating hydraulic impact hammers, and the combined spacing of each impact hammer and their guiding sliding surfaces can cause excessive deviation from the intended installation stroke direction, resulting in unnecessary oscillation deviating from the installation impact direction. This problem puts stress on mechanical and hydraulic components. The issue is particularly significant when installing objects that deviate from vertical orientation into the ground.

The known technique addresses the movement control of the impact hammer using sliding profiles integrated into the device frame, which do not solve the

problem of supporting the second impact hammer. The second impact hammer moves within a impact hammer slot created in the first impact hammer.

Brief Description of the Invention

The invention relates to a novel pile driving system that comprises at least one of the following:

- a pile driving machine,
- an impact device,
- a device frame,
- a first impact hammer,
- an impact hammer opening,
- a second impact hammer, and
- a hydraulic system.

The objective of said pile driving system is to generate sufficient hydraulic power required by said double-acting (including two impact hammers) impact device. The goal of the invention is to achieve up to double the frequency of installation impacts and the installation impact energy applied to the pile. The additional hydraulic system of the pile driving system generates hydraulic power to move the first impact hammer, while the hydraulic system of the pile driving machine generates hydraulic power to move the second impact hammer, or the impact hammers can be connected to the mentioned power sources in reverse. This is achieved with a pile driving system that comprises a pile driving machine and an impact device, which comprises a device frame, a first impact hammer with a impact hammer opening inside which a second impact hammer is moved longitudinally. The pile driving system comprises at least two separate hydraulic systems, where the first of the two separate hydraulic systems operates to move the first impact hammer, and the second operates to move the second impact hammer.

In one embodiment of the invention, the pile driving system comprises at least one independently operating additional hydraulic system that comprises a power source. The additional hydraulic system can be attached, for example, to the counterweight at the rear of the pile driving machine.

The invention may also relate to a method for timing the installation impacts of the pile driving system. The method uses two impact hammers such that the lifting time of the second impact hammer is measured with a timer to provide information for timing the installation strike of the first impact hammer and determining the lifting speed of the first impact hammer to form an installation impact sequence for the first impact hammer that results in an alternating synchronized series of installation impacts with the second impact hammer.

Furthermore, the invention may relate to a pile driving system that comprises a pile driving machine and an impact device that comprises a device frame. The pile driving system comprises a first impact hammer with a impact hammer opening inside which a second impact hammer is moved longitudinally, and the pile driving system is adapted to implement, for example, the method according to the invention described in the previous paragraph.

One advantage of the invention is that the first impact hammer and the second impact hammer can be synchronized to operate either combined with the power output of the pile driving machine and the additional hydraulic system or solely with the power output of the pile driving machine in a way that is sufficient to move the mentioned impact hammers simultaneously.

Another advantage of the invention is that two impact hammers of the known technique are incorporated within a single impact device to produce the installation function. Additionally, the invention's advantage is that the impact device can be exchanged with the impact devices of other manufacturers' pile driving machines or replace parts of an existing impact device, such as the impact hammer and hydraulic components, for creating a double-acting impact device according to the invention in a traditional single-acting impact device.

List of Figures

Figure 1 An exemplary embodiment of the invention, illustrating the pile driving system in its entirety.

Figure 2 An exemplary embodiment of the invention, depicting an impact device with one longitudinal side of the device frame partially removed. Parts of the first impact hammer and the device frame structures are removed to reveal the movement control mechanisms along their entire length from one side.

Figure 3 An exemplary embodiment of the invention, showing a diagram of two separate systems, where one system moves the first impact hammer and the other system moves the second impact hammer.

Figure 4 An exemplary embodiment of the invention, presenting a diagram of the method for achieving the operation of the double-acting impact device, which can be optimized for performance.

List of Figure References

- 101 Pile driving machine, which can be any machine used to install foundation components, for example, into the ground.
- 102 Impact device, a double-acting impact hammer comprising the first impact hammer (106) and the second impact hammer (107).
- 103 Additional hydraulic system, comprising a hydraulic unit (power source and pump), tank, control valves, and user interface. Hydraulic lines (e.g., pressure line and return line) extend from the additional hydraulic system as an example to operate the impact device (102).
- 104 Counterweight, located at the rear of the pile driving machine (101) and may for example move longitudinally along the machine.
- 106 First impact hammer.
- 107 Second impact hammer.
- 108 Lift movement timer.
- 109 Impact hammer opening, shaped and designed to allow the longitudinal movement of the second impact hammer (107) within the slot.

- 110 Device frame, which houses all functions of the impact device (102) except for power generation and the user interface, on its interior and/or exterior.
- 111 Movement control mechanism, installed between the first impact hammer (106) and the second impact hammer (107) to guide their movements. These mechanisms (111) are securely attached to the device frame (110) via at least one mounting support (116).
- 112 Installation impact, referring to the strike produced by the first or second impact hammer, with energy transferred to the installed pile.
- 113 Lift movement speed, the speed of the lifting motion of the first impact hammer (106), determined by the hydraulic flow rate and/or pressure from the pile driving machine and/or additional hydraulic system.
- 114 Spacing opening, created at least in the first impact hammer (106) and/or the second impact hammer (107) to allow the installation of the mounting support (115) without interference from the impact hammers' (106 and 107) movements and installation impact (112).
- 115 Mounting support, created at one end of at least one movement control mechanism (111).
- 117 First impact hammer movement system, comprising all necessary hydraulic components, automation components, and mechanical components to achieve the installation movement.
- 118 Second impact hammer movement system, comprising for example all necessary hydraulic components, automation components, and mechanical components to achieve the installation movement.
- 119 Lift movement timing, the initiation of the lift movement of the first impact hammer (106), which can be adjusted to optimize the sequence of installation impacts (112) between the impact hammers.
- 120 Installation impact timing, the initiation of the installation impact (112) of the first impact hammer (106), which can be adjusted to optimize the sequence of installation impacts (112) between the impact hammers.
- 121 Information processing.
- 122 Installation impact sequence.

Figure 1 shows an exemplary embodiment of the invention, featuring the pile driving machine (101) comprising an impact device (102), a counterweight (104), and an additional hydraulic system (103). The figure also depicts the installation impact (112) and its direction produced by the impact hammers.

In some exemplary embodiments of the invention the pile driving machine (101) is a piling device built on an excavator or another machine used to install piles into the ground.

In some exemplary embodiments of the invention the counterweight (104) is hydraulically movable along the longitudinal axis of the pile driving machine (101).

In some exemplary embodiments of the invention the counterweight (104) is fixedly attached to the rear of the pile driving machine (101).

In some exemplary embodiments of the invention the pile driving machine (101) does not have a counterweight (104); instead, it is replaced by the additional hydraulic system (103) and/or directly installed onto the frame of the pile driving machine (101).

In some exemplary embodiments of the invention, the additional hydraulic system (103) includes, for example, some or all of the following:

- Device frame,
- Internal combustion engine,
- Hydraulic oil tank,
- Fuel tank,
- Hoses extending to the impact device,
- Control system for the first impact hammer (106) or the second impact hammer (107),
- Control valves,
- User interface, which can be located in the cabin of the pile driving machine (101) and/or within the additional hydraulic system (103).

In some exemplary embodiments of the invention, the additional hydraulic system (103) comprises lifting means, through which the device attaches to the sliding sections of the pile driving machine's (101) boom that is lowered

to the rear in a horizontal position, known as the transport position. Through said lifting means, the additional hydraulic system (103) is raised to the desired installation height and slid along the sliding sections of the pile driving machine's (101) boom to the desired installation point, for example, against the counterweight (104) or the frame of the pile driving machine (101), where the additional hydraulic system (103) is attached.

In some exemplary embodiments of the invention, the first impact hammer (106) and the second impact hammer (107) can be configured in reverse order.

Figure 2 shows an exemplary embodiment of the invention, featuring an impact device (102) that comprises the first impact hammer (106) and the second impact hammer (107), between which at least two movement control mechanisms (111) are provided. These mechanisms are fixedly installed on the device frame (110). Each of the mentioned movement control mechanisms (111) is securely attached to the device frame (110) via at least two mounting supports (115). The mounting supports (115) are preferably installed at both ends of the movement control mechanisms (111) to minimize interference with the movement of the mentioned impact hammers (106 and 107). The figure shows an exemplary embodiment where at least one end of the first impact hammer (106) has a spacing opening (114), which functions to prevent the impact hammer from striking the mounting support (115) during the installation impact (112).

In some exemplary embodiments of the invention, the movement control mechanism (111) at the longitudinal sliding surfaces is shaped as one of the following:

- Angle iron
- Square tube
- Circular tube
- Conductor

- Or any other profile evident to a professional that functions as a conductor

In some exemplary embodiments of the invention, one or both ends of the movement control mechanism (111) are shaped to which the mounting supports (115) attach. These shapes differ from the sliding surface shapes of the movement control mechanism (111). Alternatively, these shapes at one or both ends of the movement control mechanisms (111) can be separate components attached, for example, by screw fastening to the movement control mechanisms (111).

In some exemplary embodiments of the invention, at least one surface of the movement control mechanism (111) is provided with friction and wear-reducing sliding elements, whose function is to reduce the friction produced by the installation impacts (112) between the impact hammers (106 and 107) and the movement control mechanism (111).

In some exemplary embodiments of the invention, at least one surface of the impact hammers (106 and 107) is provided with friction and wear-reducing sliding elements, whose function is to reduce the friction produced by the installation impacts (112) between the mentioned impact hammers and the movement control mechanism (111).

In some exemplary embodiments of the invention, the number of mentioned sliding elements is preferably the same as the total contact surfaces of the mentioned impact hammers (106, 107) and the movement control mechanisms (111).

In some exemplary embodiments of the invention, the movement control mechanisms (111) are attached to the device frame (110) via two mounting supports (115) such that the first mentioned mounting support (115) is attached to the upper end of the movement control mechanism (111) away from the direction of the installation impact (112) and the second mentioned mounting support (115) is below the first mounting support (115). The

distance between them is preferably, for example, 20-60 cm, but not necessarily limited to this range. The purpose of this embodiment is to remove the mounting supports (115) from the lower part of the impact device (102) and to support the movement control mechanisms (111) to align parallel to each other and relative to the device frame (110).

In some exemplary embodiments of the invention, the mounting supports (115) are attached to the device frame by screw fastening and/or welding.

In some exemplary embodiments of the invention, the spacing opening (114) is provided at at least one end of the first impact hammer (106) and/or the second impact hammer (107).

In some exemplary embodiments of the invention, the spacing opening (114) is provided on the second impact hammer (107).

In some exemplary embodiments of the invention, the spacing opening (114) is provided longitudinally at both ends of the first impact hammer (106) and/or the second impact hammer (107).

In some exemplary embodiments of the invention, the first impact hammer (106) and the second impact hammer (107) can be configured in reverse order.

Figure 3 shows an exemplary embodiment of the invention, featuring the first impact hammer movement system (117) that operates independently and is powered by the internal combustion engine and hydraulic system of the pile driving machine (101). The figure also depicts an embodiment with the second impact hammer movement system (118) that operates independently and is powered by the internal combustion engine and hydraulic system of the additional hydraulic system (103).

In some exemplary embodiments of the invention, the internal combustion engine is one of the following: a hybrid engine or an electric motor.

In some exemplary embodiments of the invention, the first impact hammer movement system (117) and the second impact hammer movement system (118) are powered solely by the pile driving machine, contrary to what is shown in the figure.

In some exemplary embodiments of the invention, the first impact hammer (106) and the second impact hammer (107) can be configured in reverse order.

Figure 4 shows an exemplary embodiment of the invention, wherein the lift movement time of the second impact hammer (107) is measured with a timer (108) that provides a value for information processing (121). This information determines the installation impact timing (120) of the first impact hammer (106), the lift movement timing (119) of the first impact hammer (106), and the lift movement speed (113) of the first impact hammer. These (120, 119, and 113) form the installation impact sequence of the first impact hammer that is measured and optimized by the information processing (121) to create an alternating synchronized installation impact series with the second impact hammer (107).

In some exemplary embodiments of the invention, wherein the lift time of the second impact hammer (107) is measured with a timer (108) that provides a value for information processing (121), determining one or a combination of the following:

- The installation impact timing (120) of the first impact hammer (106)
- The lift movement timing (119) of the first impact hammer (106)
- The lift movement speed (113) of the first impact hammer (106).

In some exemplary embodiments of the invention, in addition to the lift time measurement (108), the lift movement speed of the second impact hammer (107) is also measured.

The invention thus also relates to a pile driving system that comprises a pile driving machine and an impact device with a device frame. The pile driving system comprises a first impact hammer with an impact hammer opening inside which a second impact hammer is moved longitudinally within the impact device, and said pile driving system is adapted to be implemented in a method using two impact hammers (106, 107) such that the lift time of the second impact hammer (107) is measured with a timer (108) to provide information for determining the installation impact timing (120) of the first impact hammer (106), the lift movement timing of the first impact hammer (106), and the lift movement speed (113) of the first impact hammer to create an installation impact sequence of the first impact hammer that results in an alternating synchronized installation impact series with the second impact hammer (107). Such a pile driving system may comprise a lift time timer (108) for measuring the lift time of at least one impact hammer, the first impact hammer (106) or the second impact hammer (107). In some embodiments, the pile driving system may comprise means for processing the information from the lift timer (108) to determine the timing of the installation impact (112) of the first impact hammer (106). The pile driving system may comprise means for processing the information from the lift timer (108) to determine the lift movement timing of the first impact hammer (106) after the installation impact (112). The pile driving system may also comprise means for processing the information from the lift timer (108) to determine the lift movement speed of the first impact hammer (106).

In some exemplary embodiments of the invention, the lift movement speed (113) of the first impact hammer (106) is hydraulically adjusted by pressure and flow rate.

In some exemplary embodiments of the invention, the first impact hammer (106) and the second impact hammer (107) can switch places, for example, to implement the method shown in Figure 4.

In some exemplary embodiments of the invention, the pile driving system may be powered solely by the pile driving machine to which it is connected.

In some exemplary embodiments of the invention, the impact device includes a sensor means that measures the amount of installation impacts, the frequency of installation impacts, and the delay between installation impacts.

Claims

1. A pile driving system, comprising a pile driving machine (101) and an impact device (102) that comprises a device frame (110), characterized in that the pile driving system comprises a first impact hammer (106) with a impact hammer opening (109) inside which a second impact hammer (107) is moved longitudinally within the impact device, and the pile driving system comprises at least two separate hydraulic systems, where the first of the two separate hydraulic systems operates to move the first impact hammer (106), and the second operates to move the second impact hammer (107).
2. The pile driving system according to claim 1, characterized in that the additional hydraulic system (103) is attached to the counterweight (104) at the rear of the pile driving machine (101).