

Reverse Circulation Drilling Device with Hole Reaming Function and Usage Method Thereof

Technical Field

The present invention relates to the technical field of drilling devices, and in particular, to a reverse circulation drilling device with hole reaming function and a usage method thereof.

Background Art

During the construction of a drilled pile, in order to support an unstable stratum and ensure the safety of the ground surface or a working platform, a temporary steel casing is added at a pile hole position. In a current conventional construction process, a constructor firstly mounts the steel casing at the pile hole position by using a pile grinder and clamp out sediment in the steel casing by using a mud clamp. However, when the bottom of the steel casing reaches a hard rock stratum, the pile grinder cannot achieve continued drilling of the steel casing. At this time, it is necessary to replace the pile grinder with a hydraulic reaming drill bit to grind hard rock to expand a hole diameter, so as to be convenient for the steel casing to continue to fall. However, when the steel casing continues to penetrate into the rock stratum by about 1 meter, it is also necessary to remove the hydraulic reaming drill bit and replace the hydraulic reaming drill bit with a perpendicular drill bit to continue drilling.

The above conventional construction process requires replacing the drill bit twice, that is, requires disassembling and mounting two sets of equipment. Such a construction method is cumbersome and may also seriously delay the construction progress. Therefore, it is very necessary to invent a drilling device which is convenient for construction and accelerates the construction progress.

Summary of the Invention

Technical problems

A first object of the present invention is to provide a reverse circulation drilling device with hole reaming function, which is used for solving the problems of cumbersome construction methods and slow construction progress by utilizing existing drilling devices.

A second object of the present invention is to provide a usage method of the reverse

circulation drilling device with hole reaming function, which is implemented by applying the above reverse circulation drilling device with hole reaming function.

Technical solutions

To achieve the first object of the present invention, the present invention provides a reverse circulation drilling device with hole reaming function. The reverse circulation drilling device includes a drill pipe, wherein the drill pipe is disposed to be hollow to form a main pipeline, a composite drill bit is sleeved at the bottom of the drill pipe, the composite drill bit includes at least one down-the-hole hammer and at least one hydraulic hammer, and a part of the down-the-hole hammer extends out of the bottom surface of a housing of the composite drill bit; and the hydraulic hammer is disposed in a circumferential direction of the housing of the composite drill bit, and the hydraulic hammer can perform an extending or retracting movement along a radial direction of the housing of the composite drill bit.

In a further solution, a support is disposed above the composite drill bit, the drill pipe and the support are coaxially disposed, the hydraulic hammer is connected with the drill pipe, and a length direction of the hydraulic hammer forms an included angle with an axial direction of the drill pipe; and a high-pressure oil cylinder is disposed on the support, the high-pressure oil cylinder drives the drill pipe to move up and down, and the drill pipe drives the hydraulic hammer to perform the extending or retracting movement along the radial direction of the housing of the composite drill bit.

In a further solution, one end of the hydraulic hammer is connected to one end of a connecting piece, and the other end of the connecting piece is connected to the drill pipe.

In a further solution, the bottom surface of the housing of the composite drill bit is provided with at least one slag discharge hole, and the slag discharge hole is communicated with the main pipeline through a branch pipeline.

In a further solution, steel bars are disposed at the bottom of the slag discharge hole.

In a further solution, the reverse circulation drilling device further includes a shell, wherein the shell is disposed above the composite drill bit, the shell is sleeved outside the support, and the shell is coaxially connected with the drill pipe.

In a further solution, the number of the down-the-hole hammers is two, the two down-the-hole hammers are symmetrically disposed along an axis of the drill pipe, and each down-the-hole hammer is connected to an air compressor.

In a further solution, the number of the hydraulic hammers is four, the hydraulic hammers are uniformly disposed along a circumferential direction of the composite

drill bit, and each hydraulic hammer is connected to an external hydraulic power device. Preferably, the external hydraulic power device is provided with an oil distributor, and high-pressure pump oil is delivered to each hydraulic hammer through the oil distributor.

To achieve the second object of the present invention, the present invention provides a usage method of a reverse circulation drilling device with hole reaming function. The usage method is implemented by applying the reverse circulation drilling device with hole reaming function according to any one of the above solutions, and the usage method includes the following steps: S1: mounting a steel casing at a position where continued drilling cannot be achieved by utilizing a pile grinder; S2: mounting the reverse circulation drilling device at a construction position; S3: operating the hydraulic hammer to impact a rock wall to expand a hole diameter, so as to enable the steel casing to continue to fall; and S4: when the steel casing penetrates into a rock stratum to a first preset position, enabling the hydraulic hammer to perform a retracting movement along the radial direction of the housing of the composite drill bit, and starting the down-the-hole hammer to reciprocally move up and down to continue drilling to a second preset position.

Beneficial effects

The reverse circulation drilling device of the present invention includes the composite drill bit, and the composite drill bit is provided with the hydraulic hammer and the down-the-hole hammer, wherein the hydraulic hammer may be used for hole reaming, the down-the-hole hammer may be used for drilling, the hydraulic hammer may be retracted when not in operation without affecting subsequent drilling, and the composite drill bit can achieve hole reaming and perpendicular drilling simultaneously, so that the time for drill bit replacement can be saved in actual construction, thereby improving construction efficiency and greatly saving time and costs.

In the reverse circulation drilling device of the present invention, the support and the drill pipe are coaxially disposed, which ensures the stability of the high-pressure oil cylinder during an operation process and enables a hammering direction to form an included angle with the axis of the drill pipe. This design strengthens and ensures the progress of hole reaming operation of the hydraulic hammer, is conducive to quickly penetrating into a hard stratum, and facilitates the retraction of the high-pressure hammer simultaneously. The drill pipe is driven by the high-pressure oil cylinder to drive the hydraulic hammer to move, and the two operate in coordination, which not

only improves the working efficiency, but also enhances the safety and reliability of operation.

The reverse circulation drilling device of the present invention ensures the stability of connection between the drill pipe and the hydraulic hammer by being provided with the connecting piece.

The disposition of the slag discharge hole of the reverse circulation drilling device of the present invention ensures the normal progress of reverse circulation.

During a construction process, some crushed stones are relatively large with a diameter of more than 200 mm. In the reverse circulation drilling device of the present invention, the steel bars are disposed at the bottom of the slag discharge hole, thereby preventing the normal progress of reverse circulation from being affected due to oversized stones blocking the slag discharge hole.

The reverse circulation drilling device of the present invention is provided with the shell, thereby not only enhancing the structural stability of the whole device, but also effectively protecting the internal support and drill pipe from interference and damage by an external environment.

The reverse circulation drilling device of the present invention is provided with two down-the-hole hammers, which enables drilling operation to be more efficient. The two down-the-hole hammers operate simultaneously with a stronger impact force, which can quickly crush rocks and increase a drilling speed. Meanwhile, the air compressor provides a stable air source for the down-the-hole hammers, so as to ensure continuous and efficient operation of the down-the-hole hammers. In addition, the symmetrically disposed down-the-hole hammers is also conducive to maintaining the stability and accuracy of drilling, reducing the possibility of drilling deviation, and improving the operation quality.

In the reverse circulation drilling device, four hydraulic hammers are disposed and uniformly distributed along the circumferential direction of the composite drill bit, each hydraulic hammer is connected with the external hydraulic power device, and the high-pressure pump oil is delivered to each hydraulic hammer through the oil distributor. This design greatly improves the hole reaming efficiency. Meanwhile, it ensures that the impact force during hole reaming operation is more balanced and stronger when a plurality of hydraulic hammers operate simultaneously, thereby quickly penetrating into various complex strata. In addition, the uniformly distributed hydraulic hammers can also effectively reduce the vibration during drilling, improve the operation stability, and ensure the accuracy and quality of drilling. The external

hydraulic power device provides sufficient power support for the hydraulic hammers and guarantees the continuity and high efficiency of drilling operation.

Utilizing the reverse circulation drilling device of the present invention for construction saves the time for replacing the drill bit once in the middle, thereby greatly improving the construction efficiency, reducing the cumbersomeness of operation, and saving time and costs.

Brief Description of the Drawings

FIG. 1 is a schematic structural diagram of a reverse circulation drilling device with hole reaming function of the present invention.

FIG. 2 is an exploded structural diagram of the reverse circulation drilling device with hole reaming function of the present invention.

FIG. 3 is a bottom diagram of the reverse circulation drilling device with hole reaming function of the present invention.

FIG. 4 is a top diagram of the reverse circulation drilling device with hole reaming function of the present invention.

FIG. 5 is a sectional diagram along an A-A direction in FIG. 4.

The present invention will be further described below in conjunction with the accompanying drawings and embodiments.

Detailed Description of the Invention

Referring to FIG. 1 to FIG. 5, a reverse circulation drilling device with hole reaming function provided in this embodiment includes a drill pipe 1, wherein the drill pipe 1 is disposed to be hollow to form a main pipeline 11 and may be used for discharging drilling cuttings in reverse circulation drilling exploration.

A composite drill bit 2 is sleeved at the bottom of the drill pipe 1, and the composite drill bit 2 includes at least one down-the-hole hammer 3 and at least one hydraulic hammer 4. In this embodiment, the number of the down-the-hole hammers 3 is two, and the two down-the-hole hammers 3 are symmetrically disposed along an axis of the drill pipe 1; and the number of the hydraulic hammers 4 is four, and the hydraulic hammers 4 are uniformly disposed along a circumferential direction of the composite drill bit 2. A part of each down-the-hole hammer 3 extends out of the bottom surface of a housing of the composite drill bit 2, and the hydraulic hammer 4 can perform an extending or retracting movement along a radial direction of the housing of the composite drill bit 2.

A support 5 is disposed above the composite drill bit 2, and the drill pipe 1 and the support 5 are coaxially disposed. One end of the hydraulic hammer 4 is connected to one end of a connecting piece 6, the other end of the connecting piece 6 is connected to the drill pipe 1, and a length direction of the hydraulic hammer 4 forms an included angle with an axial direction of the drill pipe 1. A high-pressure oil cylinder 7 is disposed on the support 5, the high-pressure oil cylinder 7 drives the drill pipe 1 to move up and down, and the drill pipe 1 drives the hydraulic hammer 4 to perform the extending or retracting movement along the radial direction of the housing of the composite drill bit 2.

Each down-the-hole hammer 3 is connected to an air compressor, and the down-the-hole hammer 3 is driven by compressed air to reciprocally move up and down, so as to achieve drilling.

Each hydraulic hammer 4 is connected to an external hydraulic power device. Preferably, the external hydraulic power device is provided with an oil distributor, and high-pressure pump oil is delivered to each hydraulic hammer 4 through the oil distributor. The hydraulic hammer 4 is stably connected with external hydraulic power equipment through a high-pressure oil nozzle.

The reverse circulation drilling device further includes a shell 8, wherein the shell 8 is disposed above the composite drill bit 2, the shell 8 is sleeved outside the support 5, and the shell 8 is coaxially connected with the drill pipe 1.

The bottom surface of the housing of the composite drill bit 2 is provided with at least one slag discharge hole 9, the slag discharge hole 9 is communicated with the main pipeline 11 through a branch pipeline 91, and the branch pipeline 91 is used for conveying drilling cuttings. The number of the slag discharge holes 9 can directly affect a conveying speed of the drilling cuttings. Further, one of the branch pipelines 91 is provided with a through hole, the through hole is connected to the air compressor, and high-pressure air is blown out from bottom to top through the through hole, that is, the high-pressure air is input along a recovery direction of the drilling cuttings. The effect of the high-pressure air is to generate a pressure difference. Since a flow speed of the high-pressure air is higher than a recovery speed of the drilling cuttings, negative pressure is formed in the branch pipeline 91, which accordingly increases the recovery speed of the drilling cuttings. Moreover, when the drilling cuttings are discharged out of the drill pipe 1 in reverse circulation drilling exploration operation, a water circulation is formed, and the generated siphon effect can serve as an auxiliary force to enable the drilling cuttings to continuously extract

out the drilling cuttings from the bottom of a drill hole, thereby enhancing a reverse circulation drilling exploration effect. In this embodiment, the number of the slag discharge holes 9 is two, two branch pipelines 91 are disposed correspondingly, and the two branch pipelines 91 are communicated in the composite drill bit 2 and then enter the main pipeline 11 of the drill pipe 1, thereby facilitating the delivery of the drilling cuttings to the ground surface. During reverse circulation drilling, a flow direction of the drilling cuttings is opposite to that of a positive circulation drilling technology. The drilling cuttings flow from a space between the drill pipe and a hole wall into the main pipeline 11 of the drill pipe 1. Since the main pipeline of the drill pipe 1 is communicated with the composite drill bit 2, the drilling cuttings together with muddy water and the like are pumped to a water collection tank on the ground surface, and rock cuttings fall and settle in the water collection tank. Meanwhile, the present invention further utilizes the power of the compressed air, which enters the main pipeline 11 from the through hole of the branch pipeline 91 to provide an external force for the flow of the drilling cuttings, thereby increasing the flow speed, and thus increasing the drilling speed.

Preferably, the high-pressure air is sent out from the through hole of the branch pipeline 91 at an elevation angle of 30° . In addition, an operator may adjust the high-pressure air entering the through hole according to the recovery speed and condition of the drilling cuttings, so as to change a negative pressure numerical value in the branch pipeline 91 and a corresponding siphon acting force, thereby avoiding an excessively high or low recovery speed of the drilling cuttings, and regulating and controlling the drilling speed according to actual operation needs.

Steel bars (not shown in the drawings) are also disposed at the bottom of the slag discharge hole 9, thereby preventing the normal progress of reverse circulation from being affected due to oversized stones blocking the slag discharge hole.

More preferably, in some embodiments, the reverse circulation drilling device is also provided with an air distributor (not shown in the drawings), and the drill pipe 1 is connected to the bottom of the air distributor. The air distributor includes an air inlet pipe and air outlet pipes, wherein the air inlet pipe is connected to the air compressor, and the air outlet pipes are connected to different components of the reverse circulation drilling device, so that the high-pressure air enters different components of the reverse circulation drilling device through the air distributor, thereby independently monitoring and adjusting air pressure of communicating pipelines of various components and effectively controlling a backflow effect of reverse

circulation;

wherein the air outlet pipes include a first air outlet pipe connected to the down-the-hole hammer 3 and a second air outlet pipe connected to the branch pipeline 91. The first air outlet pipe is provided with branches connected to the two down-the-hole hammers 3 respectively, so as to provide power for the down-the-hole hammers 3 and enable the down-the-hole hammers 3 to reciprocally move up and down. The down-the-hole hammers 3 then hammer a rock stratum at the bottom of the drill hole to achieve a drilling effect. High-pressure air passing through the first air outlet pipe then enters the main pipeline 11 of the drill pipe 1 through the branch pipeline 91 to create a reverse circulation effect, so as to pump the drilling cuttings to the ground surface. The second air outlet pipe is communicated to the branch pipeline 91 and enters the main pipeline 11 of the drill pipe 1 from the through hole of the branch pipeline 91, so that the high-pressure air circulates from bottom to top into the main pipeline 11 of the drill pipe 1 to provide an external force for the flow of the drilling cuttings. On the other hand, the high-pressure air is mixed with the drilling cuttings on the branch pipeline 91, which can reduce the overall density of the drilling cuttings, correspondingly reduce the fluid resistance of the drilling cuttings, and improve the backflow effect of reverse circulation.

This embodiment further provides a usage method of the reverse circulation drilling device with hole reaming function, which is implemented by applying the reverse circulation drilling device with hole reaming function in this embodiment, and the usage method includes the following steps:

S1: mounting a steel casing at a position where continued drilling cannot be achieved by utilizing a pile grinder;

S2: mounting the reverse circulation drilling device at a construction position;

S3: operating the hydraulic hammer 4 to impact a rock wall to expand a hole diameter, so as to enable the steel casing to continue to fall; and

S4: when the steel casing penetrates into a rock stratum to a first preset position, enabling the hydraulic hammer 4 to perform a retracting movement along the radial direction of the housing of the composite drill bit 2, and starting the down-the-hole hammer 3 to reciprocally move up and down to continue drilling to a second preset position. Generally, the first preset position refers to penetrating into the rock stratum by about 1 meter.

The reverse circulation drilling device of this embodiment includes the composite drill bit 2, and the composite drill bit 2 is provided with the hydraulic hammer 4 and

the down-the-hole hammer 3, wherein the hydraulic hammer 4 may be used for hole reaming, the down-the-hole hammer 3 may be used for drilling, and the hydraulic hammer 4 may be retracted when not in operation without affecting subsequent drilling. The composite drill bit 2 can achieve hole reaming and perpendicular drilling simultaneously, so that the time for drill bit replacement can be saved in actual construction, thereby improving construction efficiency and greatly saving time and costs. Moreover, a drilling speed of the reverse circulation drilling device of this embodiment in hard rocks may reach 0.6 m/h to 1 m/h.

The above descriptions are only the preferred embodiments of the present invention, but the design concept of the present invention is not limited thereto. Without departing from the concept of the present invention, more other equivalent embodiments may also be included. Various obvious changes, readjustments and substitutions can be made by those skilled in the art without departing from the protection scope of the present invention.

Industrial applicability

The reverse circulation drilling device with hole reaming function and the usage method thereof provided in the present invention may be applied in the technical field of drilling.

The reverse circulation drilling device with hole reaming function provided in the present invention can achieve hole reaming and perpendicular drilling simultaneously, so that the time for drill bit replacement can be saved in actual construction, thereby improving construction efficiency and greatly saving time and costs. The usage method saves the time for replacing the drill bit once in the middle, thereby greatly improving the construction efficiency, reducing the cumbersomeness of operation, and saving time and costs.

Claims

1. A reverse circulation drilling device with hole reaming function, the reverse circulation drilling device comprising a drill pipe, and the drill pipe being disposed to be hollow to form a main pipeline, characterized in that,
a composite drill bit is sleeved at the bottom of the drill pipe, the composite drill bit comprises at least one down-the-hole hammer and at least one hydraulic hammer, and a part of the down-the-hole hammer extends out of the bottom surface of a housing of the composite drill bit; and the hydraulic hammer is disposed in a circumferential direction of the housing of the composite drill bit, and the hydraulic hammer can perform an extending or retracting movement along a radial direction of the housing of the composite drill bit.
2. The reverse circulation drilling device with hole reaming function of claim 1, characterized in that,
a support is disposed above the composite drill bit, the drill pipe and the support are coaxially disposed, the hydraulic hammer is connected with the drill pipe, and a length direction of the hydraulic hammer forms an included angle with an axial direction of the drill pipe; and
a high-pressure oil cylinder is disposed on the support, the high-pressure oil cylinder drives the drill pipe to move up and down, and the drill pipe drives the hydraulic hammer to perform the extending or retracting movement along the radial direction of the housing of the composite drill bit.
3. The reverse circulation drilling device with hole reaming function of claim 2, characterized in that,
one end of the hydraulic hammer is connected to one end of a connecting piece, and the other end of the connecting piece is connected to the drill pipe.
4. The reverse circulation drilling device with hole reaming function of claim 1, characterized in that,
the bottom surface of the housing of the composite drill bit is provided with at least one slag discharge hole, and the slag discharge hole is communicated with the main pipeline through a branch pipeline.
5. The reverse circulation drilling device with hole reaming function of claim 4, characterized in that,
steel bars are disposed at the bottom of the slag discharge hole.
6. The reverse circulation drilling device with hole reaming function of any one of claims 1 to 5, characterized in that,

the reverse circulation drilling device further comprises a shell, the shell is disposed above the composite drill bit, and the shell is coaxially connected with the drill pipe.

7. The reverse circulation drilling device with hole reaming function of any one of claims 1 to 5, characterized in that,

the number of the down-the-hole hammers is two, the two down-the-hole hammers are symmetrically disposed along an axis of the drill pipe, and each down-the-hole hammer is connected to an air compressor.

8. The reverse circulation drilling device with hole reaming function of any one of claims 1 to 5, characterized in that,

the number of the hydraulic hammers is four, the hydraulic hammers are uniformly disposed along a circumferential direction of the composite drill bit, and each hydraulic hammer is connected to an external hydraulic power device.

9. A usage method of a reverse circulation drilling device with hole reaming function, characterized in that the usage method is implemented by applying the reverse circulation drilling device with hole reaming function of any one of claims 1 to 8, and the usage method comprises the following steps:

S1: mounting a steel casing at a position where continued drilling cannot be achieved by utilizing a pile grinder;

S2: mounting the reverse circulation drilling device at a construction position;

S3: operating the hydraulic hammer to impact a rock wall to expand a hole diameter, so as to enable the steel casing to continue to fall; and

S4: when the steel casing penetrates into a rock stratum to a first preset position, enabling the hydraulic hammer to perform a retracting movement along the radial direction of the housing of the composite drill bit, and starting the down-the-hole hammer to reciprocally move up and down to continue drilling to a second preset position.