

METHOD AND APPARATUS FOR SEGMENTED OBSTACLE REMOVAL OF EXISTING IN-SITU TUBE WELL

TECHNICAL FIELD

The present invention relates to the field of underground obstacle removal and, in particular, to a method and apparatus for segmented obstacle removal of existing in-situ tube well.

BACKGROUND

For construction sites, underground obstacle removal is an indispensable task, which is complicated and suffers from uncertainties in the location, shape, size, depth and other information of underground obstacles. Before foundation excavation, it is necessary to clear or crush unknown underground obstacles in the construction site to avoid causing a large number of obstacles in the building of envelope construction and thus causing a delay in the construction process.

At present, obstacle removal is accomplished mainly by the following two methods: (1) use of vibratory pile driver/extractors, a common method often used to remove obstacles in areas with demanding environmental requirements, which is simple, quick, effective and produces low noise during operation but suffers from vibration; and (2) use of 360-degree full rotary drilling rigs, also known as rotating cylinder type pile extractors, a method suitable for removing deeply buried underground obstacles having a relatively large cross-sectional size, such as bored grouted piles, and relatively complex obstacles, which is a relatively mature technique but is rather expensive.

At present, there is still no satisfactory method for removing deeply buried underground obstacles having a relatively small cross-sectional size such as in-situ tube wells. As such underground obstacles reach very deep, the use of a cut-and-cover

technique will significantly affect the environment while achieving inadequate results. Moreover, since such obstacles have a small cross-sectional size, removing them with 360-degree full rotary drilling rigs is costly and uneconomic.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a method and apparatus for segmented obstacle removal of existing in-situ tube well, which are practical and operable, dispense with the use of large-scale equipment such as a vibratory pile driver/extractor or a full rotary drilling rig, less affect the environment, allow convenient, fast and safe operation, and solve the problems that may arise from underground obstacle removal, such as a significant influence on the surrounding environment and high production cost.

In order to solve the above technical problem, the present invention provide the technical solutions as follows:

an apparatus for segmented obstacle removal of existing in-situ tube well, comprising a portable water cutter for cutting the in-situ tube well, the portable water cutter comprising a water reservoir, a booster pump, a flexible high-pressure hose, a housing, a water cutting head, a motor-driven transmission, a rotary disc, a rotary pipe and a coupling means, the flexible high-pressure hose having an end connected to the booster pump, and a further end inserted into the housing and connected to an upper end of the rotary pipe by the coupling means, the water cutting head provided at a lower end of the rotary pipe, the flexible high-pressure hose fixedly connected to the coupling means, the rotary pipe able to rotate relative to the flexible high-pressure hose, the motor-driven transmission configured to drive the rotary disc to rotate therewith, the rotary disc fixedly sleeved over the rotary pipe, wherein water from the water reservoir is pressurized by the booster pump, passed successively through the flexible high-pressure hose, the coupling means and the rotary pipe and jetted out from the water

cutting head, and wherein the housing, the water cutting head, the motor-driven transmission, the rotary disc, the rotary pipe and the coupling means are able to move with the flexible high-pressure hose up and down within the in-situ tube well.

Preferably, in the above apparatus for segmented obstacle removal of existing in-situ tube well, the portable water cutter further comprises running wheels arranged around the housing so that the housing is able to travel up and down on an inner wall of the in-situ tube well by means of the running wheels.

Preferably, in the above apparatus for segmented obstacle removal of existing in-situ tube well, the coupling means is a gimbal feature.

Preferably, in the above apparatus for segmented obstacle removal of existing in-situ tube well, the gimbal feature comprises a fixed member and a rotatable member, the rotatable member coaxially connected to the fixed member so as to be able to rotate relative to the fixed member, the fixed member fixedly connected to the flexible high-pressure hose, the rotatable member fixedly connected to the rotary pipe, wherein a pressurized liquid from the flexible high-pressure hose is able to pass through the fixed member and the rotatable member to the rotary pipe.

Preferably, in the above apparatus for segmented obstacle removal of existing in-situ tube well, the coupling means comprises a coupling base defining a through bore extending vertically therethrough, the coupling base connected and sealed at an upper end of the through bore to the flexible high-pressure hose, the coupling base provided at a lower end of the through bore with a bearing, the bearing comprising an inner ring, an outer ring and a plurality of rolling balls retained in place by a retaining cage between the inner and outer rings, wherein the upper end of the rotary pipe is fixedly connected and sealed to the inner ring of the bearing, and wherein the outer ring of the bearing is fixedly connected to the coupling base.

Preferably, in the above apparatus for segmented obstacle removal of existing in-situ tube well, the flexible high-pressure hose is moved up and down by a hoist.

Preferably, in the above apparatus for segmented obstacle removal of existing in-situ tube well, the motor-driven transmission comprises a motor and a worm screw, the motor configured to drive the worm screw to rotate so that the worm screw drives the rotary disc to rotate. The worm screw and the rotary disc form a worm-gear transmission.

The present invention also discloses a method for segment-wise removal of a pre-existing in-situ tube well as an obstacle, comprising the steps of:

- i) removing soil above the in-situ tube well so as to expose a top of the in-situ tube well;
- ii) cutting the in-situ tube well into a plurality of segments from bottom to top using the above apparatus for segmented obstacle removal of existing in-situ tube well; and
- iii) successively digging out and removing the segments from top to bottom using a rotary drilling rig.

As can be seen from the above disclosed embodiments, the present invention has the following advantages over the prior art.

In the apparatus for segmented obstacle removal of existing in-situ tube well according to the present invention, the housing, the water cutting head, the motor-driven transmission, the rotary disc, the rotary pipe and the coupling means can move up and down with the flexible high-pressure hose within the in-situ tube well. Therefore, the water cutting head can reach different depths in the in-situ tube well so that the booster pump can be activated to pressurize the water from the water reservoir, and as a result the pressurized water is passed successively through the flexible high-pressure hose, the coupling means and the rotary pipe and jetted out from the water cutting head to cut the in-situ tube well. In this way, the in-situ tube well can be cut into segments suitable to be dug out by an appropriate machine, achieving removal of the in-situ tube well. This dispenses with the use of large-scale equipment such as a vibratory pile driver/extractor or a full rotary drilling rig, less affects the environment, allows convenient, fast and safe

operation, and solves the problems that may arise from underground obstacle removal, such as a significant influence on the surrounding environment and high production cost.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic diagram showing the structure of an apparatus for segmented obstacle removal of existing in-situ tube well, according to an embodiment of the present invention;

Fig. 2 is a schematic diagram showing the mounting of a water cutting head, according to an embodiment of the present invention;

Fig. 3 is a top view of Fig. 2;

Fig. 4 is a schematic diagram showing the structure of a coupling means, according to an embodiment of the present invention; and

Fig. 5 is a structural schematic of step iii) in a method for segmented obstacle removal of existing in-situ tube well, according to an embodiment of the present invention.

In these figures, 1 denotes an in-situ tube well; 2, a flexible high-pressure hose; 3, a housing; 4, a water cutting head; 5, a motor-driven transmission; 6, a rotary disc; 7, a rotary pipe; 8, a coupling means; 81, a coupling base; 82, a bearing; 9, a running wheel; 10, a portable case; and 11, a rotary drilling rig.

DETAILED DESCRIPTION

The present invention will be described in greater detail with reference to the accompanying drawings and specific embodiments. Aspects and features of the present invention will be described in detail below by means of the listed embodiments in conjunction with the accompanying drawings. It is to be noted that the drawings are provided in a very simplified form not necessarily drawn to exact scale for the only purpose of helping to explain the embodiments of the invention in a more convenient

and clearer way. Hereinafter, the terms “upper” and “lower” are used in consistence with the orientations shown in the figures, but this should not be construed as limiting the present invention.

Embodiment 1

Referring to Figs. 1 to 5, this embodiment discloses an apparatus for segmented obstacle removal of existing in-situ tube well, which includes a portable water cutter for cutting the in-situ tube well 1. The portable water cutter includes a water reservoir, a booster pump, a flexible high-pressure hose 2, a housing 3, a water cutting head 4, a motor-driven transmission 5, rotary disc 6, a rotary pipe 7 and a coupling means 8. One end of the flexible high-pressure hose 2 is connected to the booster pump, and the other end of the flexible high-pressure hose 2 is inserted inside the housing 3 and coupled to an upper end of the rotary pipe 7 by the coupling means 8. The water cutting head 4 is disposed at a lower end of the rotary pipe 7. The flexible high-pressure hose 2 is fixedly coupled to the coupling means 8, and the rotary pipe 7 is able to rotate relative to the flexible high-pressure hose 2. The motor-driven transmission 5 is adapted to drive the rotary disc 6 to rotate, and the rotary disc 6 is fixedly sleeved over the rotary pipe 7. Water from the water reservoir is pressurized by the booster pump, passed successively through the flexible high-pressure hose 2, the coupling means 8 and the rotary pipe 7, and jetted out from the water cutting head 4. The housing 3, the water cutting head 4, the motor-driven transmission 5, the rotary disc 6, the rotary pipe 7 and the coupling means 8 can move up and down with the flexible high-pressure hose 2 within the in-situ tube well 1.

In the apparatus for segmented obstacle removal of existing in-situ tube well according to the present embodiment, the housing 3, the water cutting head 4, the motor-driven transmission 5, the rotary disc 6, the rotary pipe 7 and the coupling means 8 can move up and down with the flexible high-pressure hose 2 within the in-situ tube well 1. Therefore, the water cutting head 4 can reach different depths in the in-situ tube well 1,

so that the booster pump can be activated to pressurize the water from the water reservoir, and as a result the pressurized water is passed successively through the flexible high-pressure hose 2, the coupling means 8 and the rotary pipe 7 and jetted out from the water cutting head 4 to cut the in-situ tube well 1. In this way, the in-situ tube well 1 can be cut into segments suitable to be dug out by an appropriate machine, achieving removal of the in-situ tube well 1. In order to enable the water cutting head 4 mounted on the housing 3 to stably travel along an axis of the in-situ tube well 1 and to facilitate cutting of the in-situ tube well 1, preferably, in the above apparatus for segmented obstacle removal of existing in-situ tube well, the portable water cutter further includes running wheels 9 arranged around the housing 3. By virtue of the running wheels 9, the housing 3 is able to travel up and down on an inner wall of the in-situ tube well 1.

Preferably, in the above apparatus for segmented obstacle removal of existing in-situ tube well, the coupling means 8 includes a coupling base 81 defining a through bore extending vertically therethrough. The coupling base 8 is connected and sealed at an upper end of the through bore to the flexible high-pressure hose 2 and provided at a lower end of the through bore with a bearing 82 including an inner ring, an outer ring and a number of rolling balls held in place in a retaining cage between the inner and outer rings. The upper end of the rotary pipe 7 is fixedly connected and sealed to the inner ring of the bearing, and the outer ring of the bearing is fixedly connected to the coupling base 81.

Of course, the coupling means 8 may alternatively be a gimbal feature functioning like a rotary fountain nozzle. Specifically, the gimbal feature may include a fixed member and a rotatable member, which are coaxially coupled together so that the rotatable member can rotate relative to the fixed member. The fixed member may be fixedly connected to the flexible high-pressure hose 2, and the rotatable member may be fixedly connected to the rotary pipe 7 so that a pressurized fluid from the flexible

high-pressure hose 2 can pass through the fixed and rotatable members and reach the rotary pipe 7.

Preferably, in the above apparatus for segmented obstacle removal of existing in-situ tube well, the flexible high-pressure hose 2 is raised and lowered by a hoist.

Preferably, in the above apparatus for segmented obstacle removal of existing in-situ tube well, the motor-driven transmission includes a motor and a worm screw. The motor drives the worm screw to rotate, which in turn drives the rotary disc 6 to rotate. The worm screw and the rotary disc 6 forms a worm-gear transmission which transmits power from an output shaft of the motor to the rotary disc 6, thus driving the rotary pipe 7 and the water cutting head 4 mounted thereon to rotate.

With continued reference to Figs. 1 to 5, the present invention also discloses a method for segmented obstacle removal of existing in-situ tube well, including the steps of:

i) removing soil above the in-situ tube well 1 so as to expose the top of the in-situ tube well 1;

ii) cutting the in-situ tube well 1 into a number of segments from bottom to top using the above described apparatus for segmented obstacle removal of existing in-situ tube well; and

iii) as shown in Fig. 5, successively digging out and removing the segments from top to bottom using a rotary drilling rig 10.

In the method for segmented obstacle removal of existing in-situ tube well according to the present invention, the above described apparatus for segmented obstacle removal of existing in-situ tube well is used to cut the in-situ tube well 1 into a number of segments from bottom to top. The apparatus for segmented obstacle removal of existing in-situ tube well is a portable water cutter which weighs less than 90 kg and can be operated by only two persons, greatly improving the flexibility and portability of the water cutting system and making it not limited to any operating

environment. The cut segments of the metal tube well are dug out by a rotating cylinder of the rotary drilling rig. Desirably, each segment has a length that equates to a height of the cylinder. The present invention is very practical and allows convenient construction operation. The water cutting and the subsequent segment-wise removal of the obstacle using a cylinder-type rotary drilling rig can minimize the influence of the construction process on the surrounding environment.

Any and all changes and modifications made by those of ordinary skill in the art based on the above teachings fall within the scope as defined in the appended claims.

CLAIMS

1. An apparatus for segmented obstacle removal of existing in-situ tube well, comprising a portable water cutter for cutting the in-situ tube well, the portable water cutter comprising a water reservoir, a booster pump, a flexible high-pressure hose, a housing, a water cutting head, a motor-driven transmission, a rotary disc, a rotary pipe and a coupling means, the flexible high-pressure hose having an end connected to the booster pump, and a further end inserted into the housing and connected to an upper end of the rotary pipe by the coupling means, the water cutting head provided at a lower end of the rotary pipe, the flexible high-pressure hose fixedly connected to the coupling means, the rotary pipe able to rotate relative to the flexible high-pressure hose, the motor-driven transmission configured to drive the rotary disc to rotate therewith, the rotary disc fixedly sleeved over the rotary pipe, wherein water from the water reservoir is pressurized by the booster pump, passed successively through the flexible high-pressure hose, the coupling means and the rotary pipe and jetted out from the water cutting head, and wherein the housing, the water cutting head, the motor-driven transmission, the rotary disc, the rotary pipe and the coupling means are able to move with the flexible high-pressure hose up and down within the in-situ tube well.

2. The apparatus for segmented obstacle removal of existing in-situ tube well according to claim 1, wherein the portable water cutter further comprises running wheels arranged around the housing so that the housing is able to travel up and down on an inner wall of the in-situ tube well by means of the running wheels.

3. The apparatus for segmented obstacle removal of existing in-situ tube well according to claim 1, wherein the coupling means is a gimbal feature.

4. The apparatus for segmented obstacle removal of existing in-situ tube well according to claim 3, wherein the gimbal feature comprises a fixed member and a rotatable member, the rotatable member coaxially connected to the fixed member so as to be able to rotate relative to the fixed member, the fixed member fixedly connected to

the flexible high-pressure hose, the rotatable member fixedly connected to the rotary pipe, and wherein a pressurized liquid from the flexible high-pressure hose is able to pass through the fixed member and the rotatable member to the rotary pipe.

5. The apparatus for segmented obstacle removal of existing in-situ tube well according to claim 1, wherein the coupling means comprises a coupling base defining a through bore extending vertically therethrough, the coupling base connected and sealed at an upper end of the through bore to the flexible high-pressure hose, the coupling base provided at a lower end of the through bore with a bearing, the bearing comprising an inner ring, an outer ring and a plurality of rolling balls retained in place by a retaining cage between the inner ring and the outer ring, wherein the upper end of the rotary pipe is fixedly connected and sealed to the inner ring of the bearing, and wherein the outer ring of the bearing is fixedly connected to the coupling base.

6. The apparatus for segmented obstacle removal of existing in-situ tube well according to claim 1, wherein the flexible high-pressure hose is moved up and down by a hoist.

7. The apparatus for segmented obstacle removal of existing in-situ tube well according to claim 1, wherein the motor-driven transmission comprises a motor and a worm screw, the motor configured to drive the worm screw to rotate so that the worm screw drives the rotary disc to rotate, the worm screw and the rotary disc forming a worm-gear transmission.

8. A method for segmented obstacle removal of existing in-situ tube well, comprising the steps of:

i) removing soil above the in-situ tube well so as to expose a top of the in-situ tube well;

ii) cutting the in-situ tube well into a plurality of segments from bottom to top using the apparatus for segmented obstacle removal of existing in-situ tube well of any of claims 1 to 7; and

iii) successively digging out and removing the segments from top to bottom using a rotary drilling rig.