

A Brush Drill Attachment for cleaning the Bottom of a Pile Borehole for Cast-in situ Concrete Piles

The present invention relates to a brush drill attachment to be used in the
5 process of laying foundations in the construction industry, and more particularly, to
a brush drill attachment for cleaning the bottom of a pile borehole for a cast-in situ
concrete pile.

It is necessary to lay foundations in many construction projects, such as in
constructing multi-storey buildings or bridges and in other foundation engineering
10 projects. In the construction industry, foundations formed by cast-in situ concrete
piles are usually constructed by forming pile boreholes of different shapes and
sizes, which are dug downwards using machinery such as an excavator, a digger, a
drilling rig, a mill, a screw drill, etc. until a rock layer or other suitable substratum
layer is reached. The pile boreholes are supported by casings, water, bentonite,
15 slurry or a combination of these. Then reinforcing bars are installed in the
boreholes and the pile boreholes are filled with concrete by a method known to
those skilled in the art as a Tremie method (usually the concrete is inserted
underneath the water, bentonite or slurry), so as to set the cast-in situ concrete onto
the rock layer or other suitable substratum layer. In order to ensure that a good
20 contact or boundary is formed between the bottom surface of a cast-in situ concrete
pile and the foundation substratum layer, the bottom of a pile borehole has to be
thoroughly cleaned after the pile borehole has been formed, so as to prevent loose
clay, silt, mud, gravel and other unsuitable contaminants or debris such as slurry
cakes from settling down and/or depositing onto the bottom of the pile borehole.
25 Such debris affects the boundary or connection between the bottom surface of a
cast-in situ concrete pile and the rock layer or other suitable substratum layer,
resulting in a negative effect on pile quality. However, at the moment there is no
dedicated equipment available which is specially designed for performing such
cleaning tasks.

It is therefore an object of the present invention to provide a special-purpose tool for cleaning the bottom of a borehole for a cast-in situ concrete pile.

The present invention provides a brush drill attachment for cleaning the bottom surface of a pile borehole, said attachment comprising: a body; an air chamber and a suction pipe provided in said body; a clamping plate; and a brush, wherein the clamping plate is fitted onto the lower surface of a base plate of the body, a first end of the brush is held in the clamping plate and the second end of the brush extends downwardly from the clamping plate for performing a cleaning task on the bottom surface of the pile borehole.

By connecting such a special-purpose brush drill attachment to a rotary rig, it can sweep the bottom of a pile borehole for a cast-in situ concrete pile when the special-purpose brush drill attachment rotates with the rotary rig, and debris can be removed via the airlift suction pipe.

The brush drill attachment according to the present invention is simple to make at low cost. By using such a brush drill attachment the bottom surface of a pile borehole can be cleaned effectively.

Preferred embodiments of the invention will now be described, by way of example only, and with reference to the accompanying drawings in which:

Fig. 1 is a cutaway view illustrating the structure of a brush drill attachment according to the invention;

Fig. 2 is a side view of a brush drill attachment according to the invention;

Fig. 3 is another side view of a brush drill attachment according to the invention;

Fig. 4 is a bottom view of a brush drill attachment according to the invention;

Fig. 5 is a top view of a brush drill attachment according to the invention; and

Fig. 6 illustrates a brush drill attachment according to the invention in operation.

Referring to Fig. 1, this is a perspective half cutaway view illustrating the structure of a brush drill attachment according to the present invention. As shown

in this figure, the brush drill attachment comprises a body (1), a flange (2), an air chamber (3), a suction pipe (4), clamping plates (5) and steel brushes (6). The clamping plates (5) are fitted to the lower surface of the base plate (1-2) of the body (1). The rear ends of the steel brushes (6) are fitted in the clamping plates (5) with the front ends of the steel brushes (6) extending downwards for performing the cleaning task on the bottom surface of a pile borehole.

The attachment body (1) has a cylindrical shape, the longitudinal axis of which extends in the vertical direction in use, with a suction pipe (4) fitted inside. An air chamber (3) is formed in the upper part of the body (1) and a flange (2) is provided on the top of the air chamber. The flange (2) is shaped as a circular plate with a number of through-holes provided inwardly of its peripheral edge. These through-holes are used to pass bolts for connecting to a large drilling shaft from the drilling rig arranged above the brush drill attachment in use. Two air inlet holes (2-2) are formed in the flange (2), which inlet holes (2-2) are in communication with the air chamber (3) below. The air inlet holes (2-2) are connected up to a compressed air inlet pipeline in use. Compressed air enters the air chamber (3) via the air inlet holes (2-2), then it enters the suction pipe (4) via the air holes (4-4) on the suction pipe surface, so as to reduce the silt density in this area and to cause the sand and gravel at the bottom of a pile borehole to be sucked up.

The bottom surface (1-2) of the attachment body (1) is a steel plate with reinforcing ribs. The steel plate has holes therein for connection to the clamping plates (5) by bolts. The suction pipe (4) is fitted along the longitudinal axis of the body (1), with the top of the suction pipe (4) forming an opening at the centre of the flange (2). The suction pipe (4) has a structure of a circular tube which extends downwards along the central axis of the body (1) to a point beyond the bottom of the air chamber (3). Then it extends in an oblique direction and after moving away from the longitudinal axis for a given distance it extends again in a downward direction parallel to the longitudinal axis until it reaches the bottom face (1-2) of the body (1). An inlet hole (4-2) is formed at the lower end of the suction pipe (4). The

inlet hole (4-2) is located away from the body 的 central or longitudinal axis for the purpose of sucking in water together with mud, sand and gravel. By locating it away from the centre, the sucking area is increased.

Each clamping plate (5) is formed by two opposing angled steel plates bolted together, and the steel brushes (6) are formed by a number of steel wire bundles spaced away from one another, clamped between the vertical faces of the steel plates of the clamping plate (5), and fastened by bolts.

Referring to Fig. 2, is a side view of the brush drill attachment according to one embodiment of the present invention, looking from a radial direction perpendicular to the vertical axis. It is shown in this figure that the flange (2) is on the top of the attachment body (1) while at the lowest end is the downwardly directed steel brush (6) formed by bundles of steel wire clamped by the clamping plates (5). Openings (3-2) are formed on the circumferential wall of the body (1), mainly for reducing weight.

Referring to Fig. 3, this is a view formed by rotating the drill attachment in Fig. 2 by an angle, mainly to show the way in which the suction pipe (4) fits inside the attachment body (1).

Referring to Fig. 4, this is a bottom view of the brush drill attachment according to one embodiment of the present invention. The position and shape of the clamping plates (5) is shown in this figure. There are altogether four clamping plates (5) fitted on the bottom surface of the base plate (1-2), which are disposed in a way that each two plates that are not adjacent to each other are arranged in parallel to each other while each plate is perpendicular to the plates directly adjacent to it. On the bottom surface of the base plate (1-2) the clamping plates (5) are generally evenly arranged. In Fig. 4 two or three reinforcing ribs (5-2) provided on each of the angled steel plates can be seen. Also, the inlet opening (4-2) of the suction pipe (4) is positioned away from the centre of the base surface.

The arrangement of the four clamping plates (5) is to facilitate the sweeping of the bottom surface of a pile borehole when the drill attachment rotates. The

brushes (6) are strong and tough, so they are capable of breaking off and sweeping away loose rock pieces from the bottom surface of a pile borehole. Such pieces will be sucked away by the suction pipe (4), so as to produce a clean bottom surface in the pile borehole. The shape of the clamping plates (5) can be either straight or curved.

Referring to Fig. 5, this is a top view of the brush drill attachment. It is shown in this figure that the attachment body (1) has a cylindrical shape with the flange (2) on its top. The flange (2) has a number of through-holes evenly distributed around its periphery for fitting connection bolts. In the centre of the flange (2) there is the top opening (4-3) of the suction pipe (4) and beside it there are two through-holes which are the air inlet holes (2-2) leading to the air chamber (3). The cylinder of the drill body (1) is connected to the central parts of the drill by ribbed steel plates (A) arranged in radial directions and at the lower end are the clamping plates (5). The four clamping plates also have reinforcing ribs on their top surfaces.

Referring to Fig. 6, this illustrates the operating status of the brush drill attachment according to the present invention when fitted to a drilling shaft (601) of a drilling rig. The brush drill attachment is fitted to the lower end of the large drilling shaft (601) by a connection via the flange (2). The drilling shaft (601) has a structure of three nested tubes. The outmost two smaller tubes are the inlet conduits for compressed air. An inner tube is a conduit via which water, gravel, mud and sand are lifted out of a pile borehole. Clean water from a ground filter pool is piped into a pile borehole through a conduit. Compressed air at a high pressure enters the brush drill attachment via the outer tubes of the drilling shaft (601). The compressed air passes through the air inlet holes (2-2) to enter the air chamber (3) and then passes through the air holes (4-4) on the surface (4-2) of the suction pipe (4) to produce a reduction in silt density in this area, which causes the sand and gravel at the bottom of a pile borehole to be sucked up and then to pass through the top opening (4-3) of the suction pipe to enter the inner tube of the drilling shaft (601). Through the conduit at the top of the drilling shaft (601), water, mud, sand

and gravel are transferred to a settlement tank, in which the mud, sand and gravel are settled to the bottom and the clean water is recycled. Since the drilling rig at the ground site drives the brush drill attachment to rotate, the rotating steel brush sweeps the bottom surface of the pile borehole, thus quickly making the bottom surface of the pile borehole clean. Two components are used to connect the brush drill attachment to the drilling shaft (601): a connector and a large drilling shaft. The connector has a diameter to match the large drilling shaft, and is used to connect the drilling shaft to the top of the brush drill attachment.

The brush drill attachment according to the present invention is simple in structure, easy to make, and easy to replace when the brush is worn out. Due to the effects of the brush, the bottom surface of a pile borehole can be made clean, which allows the cast-in situ concrete to bond strongly onto the rock on the bottom surface of the borehole, thereby producing a good quality pile.

Claims

1. A brush drill attachment for cleaning the bottom surface of a pile borehole, said attachment comprising: a body; an air chamber and a suction pipe provided in
5 said body; a clamping plate; and a brush, wherein the clamping plate is fitted onto the lower surface of a base plate of the body, a first end of the brush is held in the clamping plate and the second end of the brush extends downwardly from the clamping plate for performing a cleaning task on the bottom surface of the pile borehole in use.

10 2. A brush drill attachment as claimed in claim 1, wherein the clamping plate is formed by two opposing plates bolted together.

15 3. A brush drill attachment as claimed in claim 1 or 2, wherein the clamping plate has a straight shape.

4. A brush drill attachment as claimed in claim 1 or 2, wherein the clamping plate has a curved shape.

20 5. A brush drill attachment as claimed in any preceding claim, wherein four clamping plates are provided on the lower surface of the base plate.

6. A brush drill attachment as claimed in claim 5, wherein the clamping plates are evenly arranged on the lower surface of the base plate.

25 7. A brush drill attachment as claimed in any preceding claim, wherein the brush is made of metal material.

8. A brush drill attachment as claimed in any of claims 1 to 6, wherein the brush is made of non-metal material fibres connected in bundles.

9. A brush drill attachment as claimed in any of claims 1 to 7, wherein the brush is made of steel wire connected in bundles.

10. A brush drill attachment as claimed in any preceding claim, wherein the brush is clamped in the clamping plate and tightened by bolts.

11. A brush drill attachment as claimed in any preceding claim, wherein the body is cylindrical, the suction pipe comprises an inlet hole formed in the base plate of the body, and the inlet hole is offset from the longitudinal axis of the body so as to be located at a distance from the centre of the base plate.

12. A brush drill attachment as claimed in any preceding claim, the brush drill attachment further comprising a flange provided at an upper end of the body, and which in use is connected to the drilling shaft of a drilling rig arranged above the brush drill attachment, wherein the flange is shaped as a circular plate and two air inlet holes are formed in it, the air inlet holes being in communication with the air chamber located below the flange, and the air inlet holes being connected to a compressed air inlet conduit in use.