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Construction method of rotary drilling hole-forming and jet mixing cement-soil occlusion curtain piles

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ABSTRACT

The invention discloses a construction method of rotary drilling hole-forming and jet mixing cement-soil occlusion curtain piles. The technical scheme is characterized by comprising the following construction steps: measuring and lofting, positioning a rotary drilling machine, drilling the hole for the water-head pile, filling the hole with soil and grouting outside of the hole, positioning a long spiral rotary jet mixing drilling machine, constructing the water-head pile, drilling the hole for the support pile and constructing the support pile body. The method can improve the verticality of the water-head pile and form a better occlusion water-stopping effect; the constructed water-head pile is more uniform and compact, and the quality of the pile is good; and the method can be used for construction in the hard soil layers, sand gravel layers and strata with massive stones.

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FIGURES

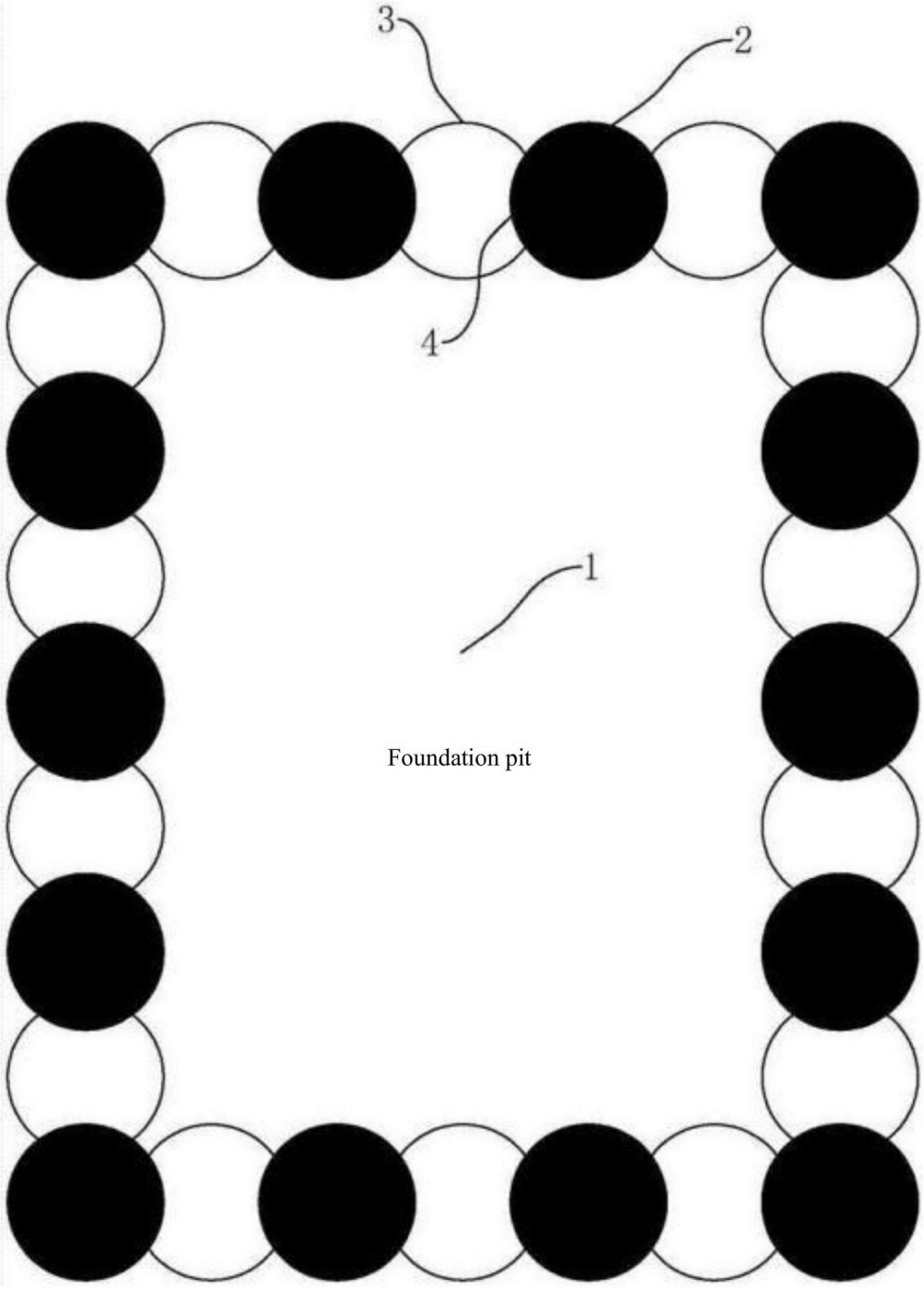


Figure 1

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Construction method of rotary drilling hole-forming and jet mixing cement-soil occlusion curtain piles

TECHNICAL FIELD

The invention relates to the field of foundation pit water curtain engineering, in particular to a construction method of water curtain piles.

BACKGROUND

As shown in Figure 1, the water curtain refers to a continuous water-stopping body which is arranged at the periphery of the foundation pit 1 of the building and is used for ensuring the excavation of the foundation pit 1 and preventing or reducing the inflow of underground water into the foundation pit on the side wall and bottom of the foundation pit. The common structure of the water curtain is that the support piles 2 and the water-head piles 3 are continuously arranged at intervals, and the support piles 2 and the water-head piles 3 are arranged in a row and partially overlapped with each other to form an occlusion part 4. The support piles 2 mainly play the role of retaining soil, and the water-head piles 3 play the role of blocking the water layer outside the foundation pit from flowing into the foundation pit. The support piles 2 generally adopt the reinforced concrete cast-in-place piles or others with strong rigidity, and the water-head pile 3 is a cement-soil pile formed by mixing the soil in the hole with cement slurry or injecting the cement slurry into the soil under high pressure, and is generally formed by mechanical construction such as a rotary jet grouting pile machine, a mixing pile machine or a long spiral rotary jet mixing drilling machine.

Although the cement-soil jet grouting pile constructed by the rotary jet grouting pile machine has good application in the fields of foundation pit supports, water curtains, foundation treatments and the like in soft soil areas, it is greatly limited when a harder soil layer is constructed; and especially when the cement-soil jet grouting pile meets a sand layer or a sand gravel layer, the jet grouting effect is greatly weakened and the cement-soil jet grouting pile cannot be implemented. Moreover, in the construction of the curtain long pile of the deep foundation pit, the verticality of rotary jet grouting piles constructed by the rotary jet grouting pile machine can not be ensured, and the design purpose can not be achieved, so that the water-stopping failure is caused.

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The cement-soil mixing pile constructed by the mixing pile machine is widely applied to the fields of foundation pit supports, water curtains, foundation treatments and the like because of easy construction and low cost, but the traditional mixing pile is greatly limited when constructing a harder soil layer, and especially it can not be implemented in a mixing sand layer or a sand-gravel layer.

Although the cement-soil pile constructed by the long spiral rotary jet mixing pile machine can well solve the problem of hole-forming and pile-forming in the hard soil area, because the verticality with the long spiral rotary jet mixing pile machine can only reach 1%, in the construction of the long pile of the deep foundation pit, the support pile and the water-head pile at the bottom of the deep foundation pit can not be engaged frequently to form a horn mouth, thereby causing the water leakage phenomenon and leading the curtain water-stopping to not meet the design requirement. In addition, the long screw pile machine is easy to jam and even can not drill when large gravel and lump stones are encountered.

SUMMARY

The invention aims to provide a construction method of rotary drilling hole-forming and jet mixing cement-soil occlusion curtain piles, which can improve the verticality of a water-head pile and form a better occlusion water-stopping effect; the constructed water-head pile is more uniform and compact, and the pile-forming quality is good; and the construction method can be used for construction in the hard soil layers, sand gravel layers and strata with massive stones.

The technical objective of the invention is achieved by the following technical scheme: the construction method of the rotary drilling hole-forming and jet mixing cement-soil occlusion curtain pile comprises the following construction steps:

Step a. Measuring and lofting: According to the design, lofting out the pile positions of the water-head piles and the support piles, and marking well;

Step b. Positioning a rotary drilling machine: Positioning the drilling machine, aligning a drill bit to the center of a water-head pile position, and adjusting the horizontal degree and the verticality of the drilling machine;

Step c. Drilling the hole for the water-head pile: Drilling according to the designed diameter and the designed depth;

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Step d. Filling soil in the hole and grouting outside of the hole: Filling good soil in the drilled hole, and mixing cement slurry in a slurry mixing pool outside the hole;

Step e. Positioning a long spiral rotary jet mixing drilling machine: Positioning the drilling machine and connecting the high-pressure pump and the high-pressure pipe;

Step f. Constructing the water-head pile: Start a high-pressure pump, starting a long spiral rotary jet mixing drilling machine, and carrying out low-pressure rotary jet mixing drilling; After the drill bit reaches the bottom of the hole, performing high-pressure jet mixing of cement slurry, while mixing the cement slurry with the soil in the hole, and simultaneously raising the drill bit at a uniform speed until it reaches the designed elevation of the pile top;

Step g. Drilling the hole for the support pile: After the strength of the water-head pile is increased, the rotary drilling machine carries out drilling holes for the support pile, and simultaneously cuts a part of the adjacent water-head pile, so that the support pile can be engaged with the water-head pile after construction;

Step h. Constructing the support pile body: Inserting a steel reinforcement cage into the hole of the support pile, pouring concrete to form a reinforced concrete support pile, and mutually engaging the reinforced concrete support pile and the water-head pile to form a continuous water curtain.

By adopting the above technical scheme, the verticality deviation of the water-head pile can be controlled within 0.3% by the rotary drilling machine, so that a better occlusion water-stopping effect can be formed; compared with the soil and stone of the original stratum, the good soil backfilled in the hole can be more fully mixed with the cement slurry, the constructed water-head pile is more uniform and compact, and the pile forming quality is good; and compared with the spiral drilling machine, the adopted rotary drilling machine has stronger drilling force, so that the method can be used for constructing the hard soil layers, sand gravel layers and strata with massive stones.

Preferably, the hole is filled with sandy soil or silty soil in step d.

By adopting the technical scheme, the sandy soil or the silty soil can be better stirred and mixed with the cement slurry to form the water-head pile with higher compactness, and the water-stopping effect is improved.

Preferably, the grouting pressure is controlled to be 0.5～1.0 MPa in the low-pressure jet mixing drilling process in step f.

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Due to the adoption of the above technical scheme, the cement slurry is continuously sprayed during the bit drilling process, the slurry jetting port is not easy to block, and meanwhile, the pressure range does not cause the waste of the cement slurry.

Preferably, the grouting pressure is controlled to be between 20～30 MPa during the uniform lifting process of the high-pressure jet mixing in step f.

By adopting the above technical scheme, the grouting pressure in the range can meet the requirements of the water-head pile with the common pile diameter, the cement slurry can effectively cut and permeate the soil in the designed pile diameter range. When the pressure is too high, the cement slurry can shoot out the pile diameter range, and unnecessary waste is caused.

Preferably, in the high-pressure rotary jet mixing lifting process in the step f, the jet mixing should be repeated for a plurality of times in the range of 2 m above the pile bottom and 2 m below the pile top.

By adopting the above technical scheme, the pile head and the pile bottom are both key parts, and the backfill soil of the pile head is easy to be incompact, so that the strengthening of jet mixing on the two parts is beneficial to improving the pile forming quality and reducing the possibility of water leakage in the later period.

Preferably, the lifting speed is from 0.5～1.0 m/min.

By adopting the above technical scheme, one-time pile formation can be basically realized in this speed; if the pile is lifted too fast, the pile is not dense and needs secondary jet mixing; and if the pile is lifted too slowly, the construction efficiency is reduced and the waste of cement slurry is caused.

Preferably, in step h, the reinforced concrete support pile is replaced by a cement soil pile with inserted section steel, and the construction method comprises the following steps: filling soil into a drilled hole of the support pile, mixing and grouting in the hole by using a long spiral rotary jet mixing drilling machine to form the cement-soil pile, inserting the section steel into the cement-soil pile to form the support pile; and after backfilling a foundation pit fertilizer groove, pulling out the section steel, and recycling.

By adopting the technical scheme, the method is more economical and environment-friendly, and the first part of the process of the support pile is the same as that of the water-head pile, so that the construction efficiency is improved, and the construction period is shorten.

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Preferably, the section steel is H-section steel.

By adopting the technical scheme, compared with other section steels, the H-shaped steel has a better transverse stress effect, so that the weight of the section steel can be reduced, materials can be saved, and the construction efficiency can be improved on the premise of ensuring safety.

In conclusion, the invention has the following beneficial effects:

1. The rotary drilling machine can control the verticality deviation of the water-head pile within 0.3%, which improves the verticality of the water-head pile, leading to better occlusion water-stopping effect;

2. The constructed water-head pile is more uniform and compact, the shrinkage phenomenon is reduced, and the reliability of the water stop curtain is improved;

3. The technology can be used for the construction in the hard soil layers, sand gravel layers and strata with massive stones;

4. Because the first constructed water-head pile has low strength and is easier to cut during drilling for the support pile;

5. A method of inserting the section steel into the cement soil pile is adopted in constructing the support pile, so that the method is more economical and environment-friendly, and part of the process before the support pile is the same as that of the water-head pile, so that the construction efficiency is improved, and the construction period is saved.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 is a schematic view of a structure of a water curtain;

Figure 2 is a flow chart of the construction process of the rotary drilling hole-forming jet mixing cement-soil occlusion curtain pile.

In the figure, 1 is a foundation pit; 2 is a support pile; 3 is a water-head pile; and 4 is an occlusion part.

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DESCRIPTION OF THE INVENTION

The invention will now be described in further detail with reference to the accompanying figures, in which the same parts are designated by the same reference numerals. It should be noted that the terms “front”, “rear”, “left”, “right”, “upper”, and “lower” as used in the following description refer to directions in the figures, while the terms “bottom” and “top”, and “inner” and “outer” refer to directions toward or away from the geometric center of a particular component, respectively.

Embodiment 1:

As shown in Figure 2, the construction method of the rotary drilling hole-forming jet mixing cement-soil occlusion curtain pile comprises the following construction steps:

Step a. Measuring and lofting: Measuring and paying off on a leveling field, inserting a wooden rod or a steel bar rod into a discharged pile position for marking, and making a pile guide beside the pile position so as to enable the pile position to be checked at any time when deviation occurs, wherein the pile guide is two marking piles which form a straight line with the center of the pile position, and the pile guide generally adopts a method of punching a deep hole on the ground by using a steel drill or a hole puncher and filling white lime powder;

Step b. Positioning a rotary drilling machine: The movement of the drilling machine by an operator according to the discharged pile position to ensure that the drilling shaft center is positioned without deviation, leveling and adjusting the vertical position of a drill rod by utilizing a self-carrying device of the rotary drilling machine, and controlling the verticality deviation of the drilling tool within 0.3%;

Step c. Drilling the hole for the water-head pile:, Drilling according to the designed diameter and the designed depth, monitoring the drilling depth in the drilling process, and avoiding overdrilling, and whether the depth of the measured hole meets the design requirement or not after hole finishing; the adopted rotary drilling machine has stronger drilling force than the spiral one, so the rotary drilling machine can be used for construction in the hard soil layers, sand gravel layers and strata with massive stones;

Step d. Filling soil in the hole, and grouting outside of the hole: After the hole is formed by the rotary drilling machine, backfilling soil in the hole; to facilitate the jet mixing implementation, the backfilling soil is preferably sandy soil or silty soil or other soil, but can not be soil with high

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organic content, especially peat soil; when the backfilling soil is too dry, water should be added to moisten; the top height of the backfilling soil should be 0.5 m higher than the top position of the designed pile;

The cement slurry is prepared in a slurry mixing machine, the water-cement ratio can be generally 1.3～1.5. After being stirred, the cement slurry is stored in a slurry storage tank through a 60-mesh fine vibrating screen; the cement must have a factory quality certificate and is sampled and detected according to batches;

Step e. Positioning a long spiral rotary jet mixing drilling machine: After the drilling machine is in place, the center of a drill bit is aligned with the center of a hole position; one end of a slurry pumping pipe is placed into a slurry storage tank, the other end of the slurry pumping pipe is connected with a high-pressure pump through a high-pressure pipe;

Step f. Constructing the water-head pile: Start a high-pressure pump, controlling the pressure to be 0.5～1.0 MPa; starting a long-screw rotary jet mixing drilling machine, drilling into the bottom of a hole at a uniform speed while carrying out rotary jet mixing; after the drill bit reaches the bottom of the hole, carrying out high-pressure rotary jetting of cement slurry, simultaneously mixing the cement slurry and soil in the hole to form the water-head pile; controlling the pressure of the high-pressure rotary jetting slurry to be 20～30 MPa; lifting the drill bit at a uniform speed by using a frequency converter, controlling the lifting speed to be 0.5～1.0 m/min until the top elevation of a designed pile is formed; the jet mixing should be repeated from several times within 2 m above the pile bottom and 2 m below the pile head to achieve a sufficient cement-oil mixture; For example, when the drill bit is raised to 2 m above the bottom of the hole, the machine will drill into the bottom of the hole again while performing high-pressure jet mixing. After two cycles, lifting the drill upwards again; if necessary, it can be lowered again to a certain depth for partial or overall jet mixing of cement slurry; compared with the soil and stone of the original stratum, the good soil backfilled in the holes can be fully mixed with the cement slurry, the constructed water-head pile is more uniform and compact, and the pile forming quality is good;

Step g. Drilling the hole for the support pile:, After the strength of the water-head pile is increased, generally after the water-head pile is finished for 3 ～ 5 days, placing a rotary drilling machine in place, leveling by utilizing a self device, adjusting the verticality of a drill rod, drilling according to the designed hole position center of the support pile, and simultaneously cutting a part of an adjacent water-head pile so that the support pile after construction can be engaged with the

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water-head pile; after reaching the design depth, pulling out the drill bit and moving the drilling machine;

Step h. Constructing the support pile body: Placing the steel bar cage which is processed in advance into the pile hole of the support pile, pouring concrete into the pile hole to form a reinforced concrete support pile, and mutually engaging the reinforced concrete support pile with the water-head pile to form a continuous water curtain.

Embodiment 2:

This embodiment is different from the first one in that: in step h, the reinforced concrete support pile is replaced by a cement soil pile with inserted section steel, and the section steel can be H-section steel.

Soil is filled in the drilled hole for the support pile, a long spiral rotary jet mixing drilling machine is used for jet mixing and grouting in the hole to form a cement soil pile, and section steel is inserted into the cement soil pile. Coating demoulding oil on the outerside of the section steel, hoisting the section steel by using hoisting equipment, sinking by using the self weight of the section steel, and vibrating and inserting the section steel into the hole by using a vibrating and pulling machine to form a support pile when the section steel cannot reach the designed depth.

After the backfilling of the foundation pit is finished, the section steel is pulled up and recovered by a special pulling machine, and the cavity left on the cement soil pile is filled with cement slurry or cement-soil slurry and sealed by clay.

This specific embodiment is merely an explanation of the present invention and is not intended to be a limitation of the invention, and those skilled in the art, upon reading this specification, may make modifications to this embodiment without creative contribution as desired, but are protected by patent laws within the scope of the claims of the present invention.

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CLAIMS

1. A construction method of rotary drilling hole-forming and jet mixing cement-soil occlusion curtain piles, which is characterized by comprising the following construction steps:

Step a. Measuring and lofting: According to the design, lofting out the pile positions of the water-head piles and the support piles, and marking well;

Setep b. Positioning a rotary drilling machine: Positioning the drilling machine, aligning a drill bit to the center of a water-head pile position, and adjusting the horizontal degree and the verticality of the drilling machine;

Step c. Drilling a hole for the water-head pile: Drilling according to the designed diameter and the designed depth;

Step d. Filling soil in the hole, and grouting outside of the hole, Filling good soil in the drilled hole, and mixing cement slurry in a slurry mixing pool outside the hole;

Step e. Positioning a long spiral rotary jet mixing drilling machine: Positioning the drilling machine and connecting the high-pressure pump and the high-pressure pipe;

Step f. Constructing the water-head pile: Start a high-pressure pump, starting a long spiral rotary jet mixing drilling machine, and carrying out low-pressure rotary jet mixing drilling; After the drill bit reaches the bottom of the hole, performing high-pressure jet mixing of cement slurry, while mixing the cement slurry with the soil in the hole, and simultaneously raising the drill bit at a uniform speed until it reaches the designed elevation of the pile top;

Step g. Drilling a hole for the support pile: After the strength of the water-head pile is increased, the rotary drilling machine carries out drilling holes for the support pile, and simultaneously cuts a part of the adjacent water-head pile, so that the support pile can be engaged with the water-head pile after construction;

Step h. Constructing the support pile body: Inserting a steel reinforcement cage into the hole of the support pile, pouring concrete to form a reinforced concrete support pile, and mutually engaging the reinforced concrete support pile and the water-head pile to form a continuous water curtain.

2. The construction method according to claim 1, wherein sandy soil or silty soil is filled in the hole in step d.

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3. The construction method according to claim 1, wherein in step f, the grouting pressure is controlled to be 0.5～1.0 MPa in the low-pressure rotary jet mixing drilling process.

4. The construction method according to claim 1, wherein in step f, the grouting pressure is controlled to be 20～30 MPa in the process of high-pressure rotary jet mixing and uniform-speed lifting.

5. The construction method according to claim 1, wherein in step f, in the process of high-pressure rotary jet mixing and lifting, the jet mixing should be repeated for a plurality of times in the range of 2 m above the bottom of the pile and 2 m below the top of the pile.

6. The construction method according to claim 1, wherein the lifting speed is 0.5～1.0 m/min.

7. The construction method according to claim 1, wherein in step h, the reinforced concrete support pile is replaced by the cement soil pile with inserted section steel. The construction method comprises the following steps: filling soil into the drilled hole of the support pile, jet mixing and grouting in the hole to form the cement-soil pile by using a long spiral rotary jet mixing drilling machine; inserting the section steel into the cement soil pile to form the support pile; and after backfilling a foundation pit fertilizer groove, pulling out the section steel, and recycling.

8. The construction method according to claim 7, wherein the section steel is H section steel.

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FIGURES

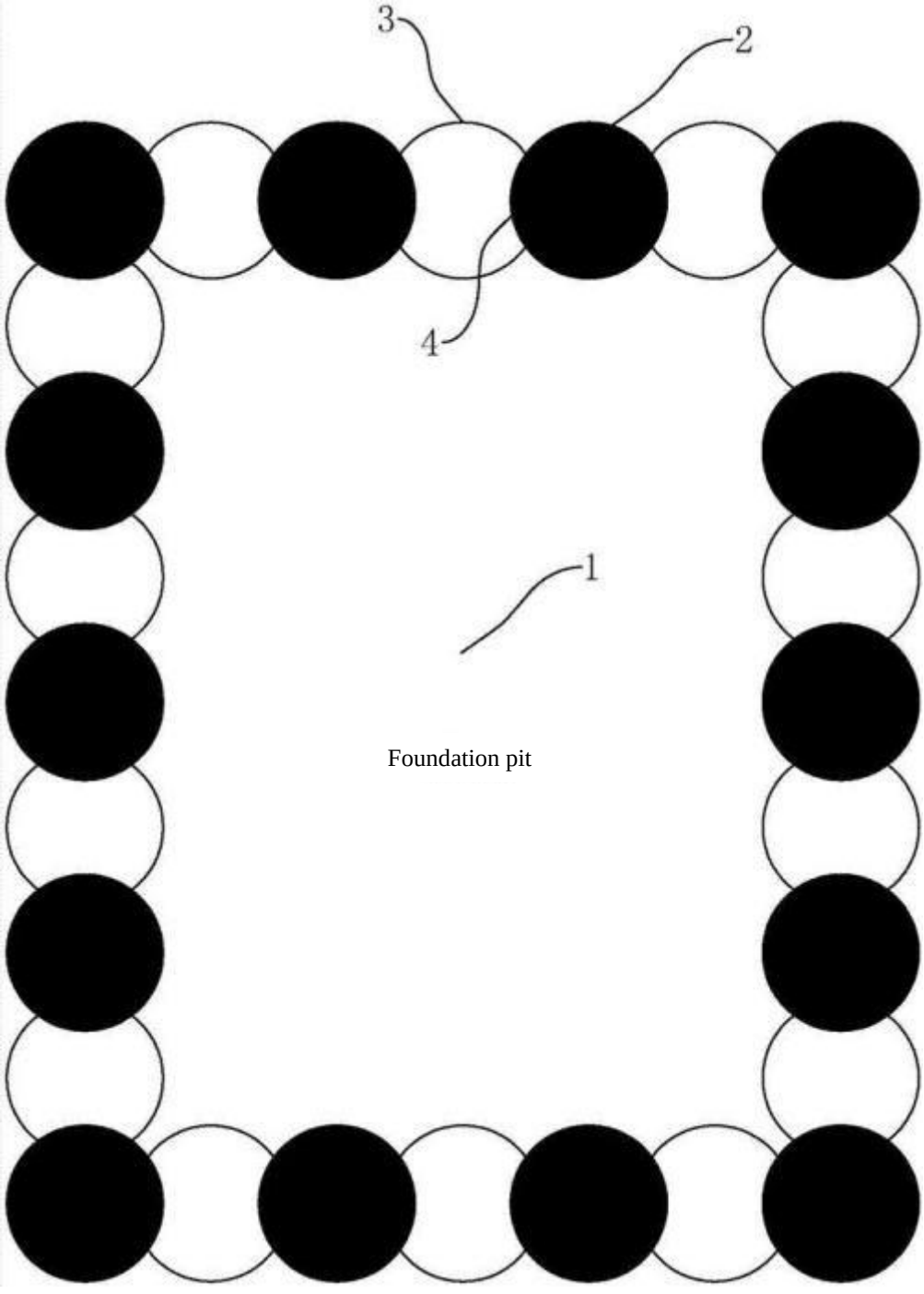


Figure 1

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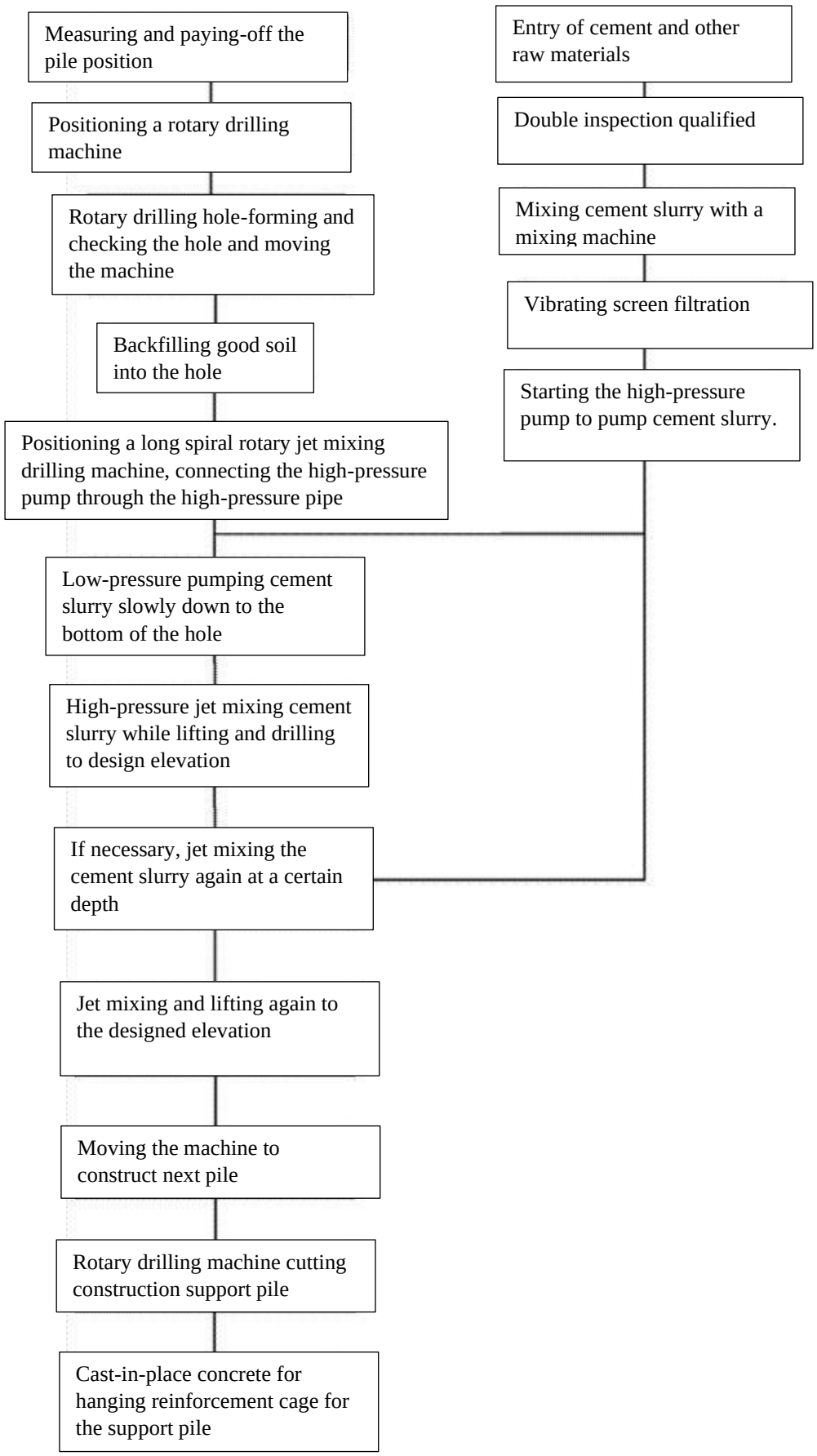


Figure 2