

CONCRETE PIPE PILE BOTTOM GROUTING APPARATUS AND USE METHOD THEREFOR

CROSS REFERENCE TO RELEVANT APPLICATIONS

5 **[0001]** The present disclosure claims the priority of the Chinese patent application filed on February 13th, 2023 before the Chinese Patent Office with the application number of 202310105443.6 and the title of "CONCRETE PIPE PILE BOTTOM GROUTING APPARATUS AND USE METHOD THEREFOR", which is incorporated herein in its entirety by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to the technical field of foundation construction, and particularly relates to a tubular-pile bottom-grouting device and a usage method thereof.

BACKGROUND

15 **[0003]** In construction, if the geological conditions are poor and the foundation has a low bearing force, it is required to drive tubular piles under the ground, so as to transfer the weight of the construction thereover via the tubular piles to the lower-layer bearing stratum having a high bearing force, merely by which the stability and the safety of the construction can be ensured.

20 The single-pile bearing capacity of the tubular piles decides the quantity of the tubular piles that are required to be provided in the foundation construction, wherein the higher the single-pile bearing capacity of the tubular piles is, the lower the quantity of the required tubular piles is.

[0004] In the conventional tubular-pile construction, a grouting device is added at the bottom, and the grouting device increases the force bearing area of the bottom end of the tubular pile, to

25 increase the single-pile bearing capacity of the tubular pile. The grouting device comprises a grouting bag and a grouting pipe whose one end is inserted into the grouting bag. After the grouting device has been driven under the ground along with the tubular pile, grouting is performed into the grouting bag by using the grouting pipe. After the continuous grouting has caused the grouting bag to crack, part of the grout permeates into the surrounding earth, and after

30 the grout has solidified, the grout at the bottom of the tubular pile solidifies integrally with the surrounding earth. As restricted by the room at the bottom of the tubular pile, the volume of the solidified part formed after the grouting is very low; in other words, the contact area between the solidified part and the surrounding earth is low. Therefore, the bearing force of the tubular pile is increased to a low extent. Furthermore, merely a very small part of the grout can permeate into

35 the earth, and therefore the friction between the solidified part and the surrounding earth is low.

Therefore, such a grouting device has a poor effect of increasing the bearing capacity of the tubular pile.

SUMMARY

5 **[0005]** Therefore, the technical problem that the present disclosure seeks to solve is to overcome the defect of the grouting devices in the prior art that the solidified part formed at the bottom of the tubular pile has a low volume, and the friction between the tubular pile and the surrounding earth is low, which results in a poor effect of increasing the bearing capacity of the tubular pile, so as to provide a tubular-pile bottom-grouting device and a usage method thereof
10 that can form a larger solidified part at the bottom of the tubular pile and obtain a higher friction between the side wall of the tubular pile and the surrounding earth.

[0006] In order to solve the above problem, the present disclosure provides a tubular-pile bottom-grouting device, wherein the device comprises:

[0007] a grouting bag, wherein the grouting bag is inflatable when pushed by an internal grout;

15 **[0008]** at least one first grouting pipe, wherein the first grouting pipe is connected to the grouting bag, and one end of the first grouting pipe protrudes into the grouting bag; and

[0009] at least one second grouting pipe, wherein the second grouting pipe is connected to the grouting bag, and the second grouting pipe extends throughout the grouting bag.

[0010] Optionally, the grouting bag has openings at two ends, and a first connector and a
20 second connector are provided at the openings.

[0011] Optionally, first mounting holes are provided in the first connector, a quantity of the first mounting holes is equal to a sum of a quantity of the first grouting pipe and a quantity of the second grouting pipe, a second mounting hole is provided in the second connector, a quantity of the second mounting hole is equal to the quantity of the second grouting pipe, one end of the first
25 grouting pipe penetrates one instance of the first mounting holes and protrudes into the grouting bag, the second grouting pipe sequentially penetrates one instance of the first mounting holes and the second mounting hole, and two ends of the second grouting pipe are outside the grouting bag.

[0012] Optionally, a plurality of grouting holes are provided in a side wall of a pipe section of the first grouting pipe that is located inside the grouting bag, and a plurality of grouting holes are
30 provided in a side wall of a pipe section of one end of the second grouting pipe that is outside the grouting bag and is closer to the second mounting hole.

[0013] Optionally, a one-way grouting valve is outside the grouting holes.

[0014] Optionally, the openings of the grouting bag are connected to the first connector and the second connector by fixers.

35 **[0015]** Optionally, a blocking plate nests an exterior of the first connector.

[0016] Optionally, the blocking plate has a flexible skirt edge.

[0017] A method for using a tubular-pile bottom-grouting device, applied to the tubular-pile bottom-grouting device, wherein the method comprises the steps of:

[0018] providing the tubular-pile bottom-grouting device at a bottom of a tubular pile;

5 **[0019]** grouting into the second grouting pipe, to cause a grout to fill a gap between an outer wall of the grouting bag and a surrounding earth, and grouting between an outer wall of the tubular pile and a surrounding disturbed soil zone to form a grout lode;

[0020] grouting into the first grouting pipe, to cause the grouting bag to inflate, and push the grout and the earth outside the grouting bag; and

10 **[0021]** the grout injected from the first grouting pipe and the second grouting pipe solidifying to form an expanded head.

[0022] Optionally, between the step of providing the tubular-pile bottom-grouting device at the bottom of the tubular pile and the step of grouting into the second grouting pipe, to cause the grout to fill the gap between the outer wall of the grouting bag and the surrounding earth, the
15 method further comprises:

[0023] connecting a blocking plate to an inner wall of a bottom end of the tubular pile, and injecting a cement slurry or a cement mortar to a top of the blocking plate.

[0024] The present disclosure has the following advantages:

[0025] 1. The tubular-pile bottom-grouting device according to the present disclosure
20 comprises a grouting bag, at least one first grouting pipe and at least one second grouting pipe. The first grouting pipe is connected to the grouting bag, and one end of the first grouting pipe protrudes into the grouting bag. The first grouting pipe may grout into the grouting bag, and the grouting bag is inflated with the increasing of the internal grout. The second grouting pipe is connected to the grouting bag, and extends throughout the grouting bag. The second grouting
25 pipe may grout to the exterior of the grouting bag. Grouting is performed to the interior and the exterior of the grouting bag by using the first grouting pipe and the second grouting pipe respectively, and, finally, after the grout has solidified, a larger solidified part can be formed at the bottom of the tubular pile, to increase the force bearing area of the bottom end of the tubular pile. The grout injected into the grouting bag via the first grouting pipe can push the grout
30 injected to the exterior of the grouting bag via the second grouting pipe, and the grout permeates into the surrounding earth, to increase the friction between the expanded head and the surrounding earth, and thus increase the single-pile bearing capacity of the tubular pile.

[0026] 2. In the tubular-pile bottom-grouting device according to the present disclosure, the grouting bag has openings at the two ends, a first connector and a second connector are provided
35 at the openings, and the first grouting pipe and the second grouting pipe are connected and fixed

by the first connector and the second connector. Such a connecting structure is simple, has a good practical applicability, and is convenient for construction operations.

[0027] 3. In the tubular-pile bottom-grouting device according to the present disclosure, a one-way grouting valve is outside the grouting holes. The one-way grouting valve is preferably a rubber sheath. By providing the rubber sheath, unidirectional grouting can be realized. In other words, the grout can merely flow from the first grouting pipe into the grouting bag and flow from the second grouting pipe to the exterior of the grouting bag, the grout inside the first grouting pipe and the second grouting pipe flows out of the grouting holes, the rubber sheath is pushed away by the pressure of the grout, the grout flows out between the rubber sheath and the first grouting pipe and the second grouting pipe, and the grout outside the rubber sheath cannot flow into the first grouting pipe and the second grouting pipe. By providing the one-way grouting valve, unidirectional grouting can be realized, to prevent upward returning of the grout inside the first grouting pipe and the second grouting pipe in the grouting.

[0028] 4. In the tubular-pile bottom-grouting device according to the present disclosure, a blocking plate nests the exterior of the first connector, and the blocking plate has a flexible skirt edge. By connecting the flexible skirt edge of the blocking plate to the inner wall of the tubular pile, it can be prevented that the grout injected from the first grouting pipe and the second grouting pipe upwardly returns from the bottom of the tubular pile into the tubular pile, to cause the grout to reside at the bottom of the tubular pile, and solidify to form the expanded head.

[0029] 5. In the method for using a tubular-pile bottom-grouting device according to the present disclosure, after the tubular-pile bottom-grouting device has been provided at the bottom of the tubular pile, by using the second grouting pipe, the grouting is performed between the outer wall of the grouting bag and the surrounding earth, and between the outer wall of the tubular pile and the surrounding disturbed soil zone, so that the grout permeates into the surrounding earth to form the grout lode, to increase the friction between the outer wall of the tubular pile and the earth. By grouting into the grouting bag by using the first grouting pipe, the grouting bag can be caused to inflate, and push the surrounding earth, to increase the amount of the grout that is outside the grouting bag and permeates into the earth, and finally the expanded head of a high volume can be formed at the bottom end of the tubular pile, to increase the force bearing area of the bottom of the tubular pile, thereby increasing the bearing capacity of the tubular pile.

[0030] The above description is merely a summary of the technical solutions of the present disclosure. In order to more clearly know the elements of the present disclosure to enable the implementation according to the contents of the description, and in order to make the above and

other purposes, features and advantages of the present disclosure more apparent and understandable, the particular embodiments of the present disclosure will be provided below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] In order to more clearly illustrate the technical solutions of the particular embodiments of the present disclosure or the prior art, the figures that are required to describe the particular embodiments or the prior art will be briefly described below. Apparently, the figures that are described below are embodiments of the present disclosure, and a person skilled in the art can obtain other figures according to these figures without paying creative work.

[0032] FIG. 1 is a schematic diagram of a tubular-pile bottom-grouting device according to the present disclosure;

[0033] FIG. 2 is a sectional view of a tubular-pile bottom-grouting device according to the present disclosure;

[0034] FIG. 3 is a schematic diagram of the pile sinking in the first step of a method for using a tubular-pile bottom-grouting device according to the present disclosure;

[0035] FIG. 4 is a schematic diagram of the pile-toe disengagement in the first step of a method for using a tubular-pile bottom-grouting device according to the present disclosure;

[0036] FIG. 5 is a schematic diagram of the grouting to the top of the blocking plate in a method for using a tubular-pile bottom-grouting device according to the present disclosure;

[0037] FIG. 6 is a schematic diagram of the second step of a method for using a tubular-pile bottom-grouting device according to the present disclosure;

[0038] FIG. 7 is a schematic diagram of the third step of a method for using a tubular-pile bottom-grouting device according to the present disclosure; and

[0039] FIG. 8 is a schematic diagram of the fourth step of a method for using a tubular-pile bottom-grouting device according to the present disclosure.

[0040] Description of the reference numbers:

[0041] 1: grouting bag; 2: first grouting pipe; 3: second grouting pipe; 4: first connector; 5: second connector; 6: grouting holes; 7: fixers; 8: blocking plate; 801: flexible skirt edge; and 9: tubular pile.

DETAILED DESCRIPTION

[0042] The technical solutions of the present disclosure will be clearly and completely described below with reference to the drawings. Apparently, the described embodiments are merely certain embodiments of the present disclosure, rather than all of the embodiments. All of the other embodiments that a person skilled in the art obtains on the basis of the embodiments of

the present disclosure without paying creative work fall within the protection scope of the present disclosure.

[0043] In the description of the present disclosure, it should be noted that the terms that indicate orientation or position relations, such as "center", "upper", "lower", "left", "right", "vertical", "horizontal", "inside" and "outside", are based on the orientation or position relations shown in the drawings, and are merely for conveniently describing the present disclosure and simplifying the description, rather than indicating or implying that the device or element must have the specific orientation and be constructed and operated according to the specific orientation. Therefore, they should not be construed as a limitation on the present disclosure. Moreover, the terms "first", "second" and "third" are merely for the purpose of describing, and should not be construed as indicating or implying the degrees of importance.

[0044] In the description of the present disclosure, it should be noted that, unless explicitly defined or limited otherwise, the terms "mount", "connect" and "link" should be interpreted broadly. For example, it may be fixed connection, detachable connection, or integral connection; it may be mechanical connection or electrical connection; and it may be direct connection or indirect connection by an intermediate medium, and may be the internal communication between two elements. For a person skilled in the art, the particular meanings of the above terms in the present disclosure may be comprehended according to particular situations.

[0045] Furthermore, the technical features involved in the different embodiments of the present disclosure described below can be combined with each other as long as they do not conflict with each other.

[0046] As shown in FIGS. 1 and 2, FIGS. 1 and 2 are preferable embodiments of the tubular-pile bottom-grouting device according to the present disclosure. In the foundation construction, the tubular-pile bottom-grouting device may be provided at the bottom of the tubular pile, to increase the single-pile bearing capacity of the tubular pile, thereby reducing the quantity of the tubular piles that are used in the whole construction process, to reduce the construction cost.

[0047] The tubular-pile bottom-grouting device comprises: a grouting bag 1, at least one first grouting pipe 2 and at least one second grouting pipe 3. The grouting bag 1 is inflatable when pushed by the internal grout, and cannot crack. In other words, the grouting bag 1 has a contracting state when no grout is injected into the interior and an inflating state when inflating when the grout is injected. The first grouting pipe 2 is connected to the grouting bag 1, and one end of the first grouting pipe 2 protrudes into the grouting bag 1, and may grout into the interior of the grouting bag 1. With the continuous grouting into the interior of the grouting bag 1, the grouting bag 1 can be gradually inflated and increasingly larger. The second grouting pipe 3 is

connected to the grouting bag 1, and the second grouting pipe 3 extends throughout the grouting bag 1, whereby grouting may be performed to the exterior of the grouting bag 1 by using the second grouting pipe 3.

[0048] Particularly, in the present embodiment, both of the quantities of the first grouting pipe 2 and the second grouting pipe 3 are one. In construction, the tubular-pile bottom-grouting device is provided at the bottom of a tubular pile 9, grouting is performed to the interior and the exterior of the grouting bag 1 by using the first grouting pipe 2 and the second grouting pipe 3 respectively, and finally an expanded head can be formed at the bottom of the tubular pile 9. Furthermore, the expanded head solidifies integrally with the surrounding earth, which increases the bearing capacity of the tubular pile 9.

[0049] Optionally, the material of the grouting bag 1 may be a high-strength chemically synthesized fiber cloth such as wrapping fabric, for example, terylene, chinlon and orlon, and may also be a plastic thin-film material, for example, polyvinyl chloride, polyethylene and polypropylene, or another material that is suitable to contain the grout, has a constant volume in the filling state and does not crack under the designed grouting pressure value, for example, plastic and rubber. The grouting bag may be of a single-layer structure, and may also be of a multilayer structure. Particularly, in the present embodiment, the grouting bag 1 is made from a wrapping fabric, and is of a single-layer structure.

[0050] Optionally, the grouting bag 1 has openings at the two ends, and a first connector 4 and a second connector 5 are provided at the openings. The openings of the grouting bag 1 are connected to the first connector 4 and the second connector 5 by fixers 7. In the present embodiment, the fixers 7 are anchor ears, and the anchor ears anchor the grouting bag 1 to the first connector 4 and the second connector 5, to prevent the grout from flowing out of the openings of the grouting bag 1.

[0051] Furthermore, in order to prevent the grouting bag 1 from contacting the rough inner wall of the tubular pile 9 and being scratched to open after inflated by the grouting, which affects the subsequent grouting into the grouting bag 1, to cause that the expanded head cannot be formed, the connection position between the grouting bag 1 and the first connector 4 may be adjusted to prevent the grouting bag 1 from being scratched to open. Particularly, after the tubular-pile bottom-grouting device has been placed at the bottom of the tubular pile 9, it is merely required that the connection position between the grouting bag 1 and the first connector 4 is located below the bottom face of the tubular pile 9, and, subsequently, the grouting bag 1, when inflated by the grouting, does not contact the inner wall of the tubular pile 9, and thus is not scratched to open.

[0052] If the connection position between the grouting bag 1 and the first connector 4 is located inside the tubular pile 9, a geotextile shawl may be provided at the connection between the grouting bag 1 and the first connector 4 for protection. The geotextile shawl covers the exterior of the grouting bag 1, and the geotextile shawl is caused to contact the rough inner wall of the tubular pile 9, to protect the grouting bag 1 from being scratched to open.

[0053] Waterstops may be provided at the connections between the grouting bag 1 and the first connector 4 and the second connector 5. The waterstops made from a water stopping material serve for sealing, and after the grout inside the grouting bag 1 contacts the waterstops, the waterstops can harden to seal the connections, to prevent the grout from being leaked.

[0054] First mounting holes are provided in the first connector 4, the quantity of the first mounting holes is equal to the sum of the quantity of the first grouting pipe 2 and the quantity of the second grouting pipe 3, a second mounting hole is provided in the second connector 5, and the quantity of the second mounting hole is equal to the quantity of the second grouting pipe 3. One end of the first grouting pipe 2 penetrates one first mounting hole and protrudes into the grouting bag 1, the second grouting pipe 3 sequentially penetrates one first mounting hole and the second mounting hole, and the two ends of the second grouting pipe 3 are outside the grouting bag 1. Particularly, in the present embodiment, because both of the quantities of the first grouting pipe 2 and the second grouting pipe 3 are one, the quantity of the first mounting holes in the first connector 4 is two, the two first mounting holes are adjacent to each other, and the quantity of the second mounting hole in the second connector 5 is one. The first connector 4 and the second connector 5 are of a cylindrical shape, and each may be manufactured by using a steel cylinder provided with end covers at the two ends. The two end covers of the first connector 4 are provided with the first mounting holes of the corresponding quantity, and the two end covers of the second connector 5 are provided with the second mounting holes of the corresponding quantity. The connections of the first mounting holes and the second mounting hole with the first grouting pipe 2 and the second grouting pipe 3 are required to be sealed. In the present embodiment, by welding the connections, the sealing and the fixing of the first grouting pipe 2 and the second grouting pipe 3 are realized.

[0055] Furthermore, a blocking plate 8 nests the exterior of the first connector 4. The blocking plate 8 has a flexible skirt edge. The flexible skirt edge may be made from a material such as rubber, silica gel and plastic. The middle part of the blocking plate 8 is a rigid plate, which can increase the weight-bearing capacity and the rigidity of the blocking plate. The flexible skirt edge surrounds the rigid plate. In the present embodiment, the rigid plate is a circular steel plate, the flexible skirt edge is an annular rubber plate, and the outer diameter of the flexible skirt edge is slightly greater than the inner diameter of the tubular pile 9. By adhering the flexible skirt edge

to the inner wall of the tubular pile 9, the connection between the blocking plate 8 and the inner wall of the tubular pile 9 is realized, and subsequently grouting is performed to the top of the blocking plate. After the grout has solidified, upward returning of the grout injected from the first grouting pipe and the second grouting pipe along the cavity of the tubular pile 9 can be prevented.

[0056] A plurality of grouting holes 6 are provided in the side wall of a pipe section of the first grouting pipe 2 that is located inside the grouting bag 1, and a plurality of grouting holes 6 are provided in the side wall of a pipe section of the end of the second grouting pipe 3 that is outside the grouting bag 1 and is closer to the second mounting hole. In the present embodiment, multiple rows of the grouting holes 6 are provided separately along the side wall of the pipe section, and in each of the rows a plurality of grouting holes 6 are provided separately and evenly. The grout injected into the first grouting pipe 2 and the second grouting pipe 3 flows out of the grouting holes 6, and a one-way grouting valve is outside the grouting holes 6, which can realize unidirectional grouting. Particularly, in the present embodiment, the one-way grouting valve is a rubber sheath, and the rubber sheath nests the exterior of the grouting holes 6, which can control the direction of the flowing-through of the grout, to prevent the grout from flowing into the first grouting pipe 2 and the second grouting pipe 3.

[0057] In another embodiment, the quantities of the first grouting pipe 2 and the second grouting pipe 3 may also be two, three and so on, and the first grouting pipe 2 and the second grouting pipe 3 may be pipes of fixed lengths, and may also be stretching pipes of variable lengths.

[0058] In another embodiment, the material of the grouting bag 1 may also be plastic, rubber, a plastic thin-film material and so on, and the grouting bag 1 may also be of a multilayer structure.

[0059] In another embodiment, the first mounting holes and the second mounting hole may also be separate.

[0060] In another embodiment, the first connector and the second connector may be of another shape such as square, and the material may also be stainless steel, plastic and so on.

[0061] In another embodiment, the fixers 7 may also be steel wires, the steel wires are tightened to connect the grouting bag 1 to the first connector 4 and the second connector 5, and the fixers 7 may also be hoops.

[0062] In another embodiment, the flexible skirt edge of the blocking plate 8 may also be made from silica gel, plastic and so on, and its shape may also be a polygon, provided that it can be completely adhered and connected to the inner wall of the tubular pile 9.

[0063] The present embodiment further provides a method for using a tubular-pile bottom-grouting device, applied to the tubular-pile bottom-grouting device. Because the

tubular-pile bottom-grouting device has the same structure as that of the tubular-pile bottom-grouting device according to the above embodiments, it is not discussed further herein.

[0064] The method for using a tubular-pile bottom-grouting device comprises the following steps:

5 **[0065]** The first step: providing the tubular-pile bottom-grouting device at the bottom of the tubular pile 9.

[0066] As shown in FIG. 3, before this step, the method further comprises a step of knocking the tubular pile 9 to under the ground. Particularly, by using a pile driver, by means of hammering or static pressing, the tubular pile 9 is sunk to the designed elevation position under the ground, to cause the pile toe of the tubular pile 9 to enter the bearing stratum. Subsequently, as shown in FIG. 4, a round steel bar or piercing hammer penetrates the cavity of the pile body and hammers the pile toe, to cause the pile toe to disengage from the pile tip, thereby forming a certain space between the pile toe and the pile body. However, during the pile sinking, as hammered and pressed by the devices such as the pile driver, the earth surrounding the outer wall of the tubular pile 9 forms a disturbed soil zone, wherein the earth of the disturbed soil zone is more loose. Furthermore, part of the earth at the bottom end of the tubular pile 9 collapses, and is accumulated between the pile toe and the pile body.

15 **[0067]** Subsequently, the tubular-pile bottom-grouting device is sunk via the cavity of the pile body to the bottom of the tubular pile 9, and the grouting pipe of a grouting device on the ground is communicated with the first grouting pipe 2 and the second grouting pipe 3, wherein the grouting pipe may be connected with the first grouting pipe 2 and the second grouting pipe 3 by means of screwed connection, welding, liquid welding, adhesive bonding and so on.

[0068] The second step: grouting into the second grouting pipe 3, to cause the grout to fill the gap between the outer wall of the grouting bag 1 and the surrounding earth, and grouting between the outer wall of the tubular pile 9 and the surrounding disturbed soil zone to form the grout lode.

[0069] As shown in FIG. 5, before this step, the method further comprises connecting a blocking plate 8 to the inner wall of the bottom end of the tubular pile 9, and injecting a cement slurry or a cement mortar to the top of the blocking plate 8. The blocking plate 8 has a flexible skirt edge, whose outer diameter is slightly greater than the inner diameter of the tubular pile. By clamping the first grouting pipe and the second grouting pipe, the blocking plate 8 is sunk to the bottom of the tubular pile, to cause the flexible skirt edge to closely adhere to the inner wall of the tubular pile 9. After the designated position has been reached, grouting is performed from the cavity of the pile body, to grout cement slurry or cement mortar to the top of the blocking plate 8 to a certain height. After the cement slurry or cement mortar has solidified, subsequently the

grouting into the second grouting pipe is started. This step can prevent that, in the subsequent grouting into the first grouting pipe 2 and the second grouting pipe 3, the grout upwardly returns inside the cavity of the tubular pile 9.

[0070] As shown in FIG. 6, by grouting to the exterior of the grouting bag 1 by using the second grouting pipe 3, the grout is caused to fill the gap between the outer wall of the grouting bag 1 and the surrounding earth. Part of the grout can permeate into the surrounding earth, the grout is injected between the outer wall of the tubular pile 9 and the surrounding disturbed soil zone, and the grout permeates into the surrounding earth to form the split-shaped grout lode. After the grout has solidified, the friction between the tubular pile 9 and the earth can be increased.

[0071] The third step: grouting into the first grouting pipe 2, to cause the grouting bag 1 to inflate, and push the grout and the earth outside the grouting bag 1.

[0072] As shown in FIG. 7, grouting is performed into the first grouting pipe 2. With the accumulation of the grout inside the grouting bag 1, the grouting bag 1 gradually inflates, and pushes the grout and the earth outside the grouting bag 1, and the amount of the grout that permeates into the surrounding earth increases. The amount of the grout injected into the first grouting pipe 2 may be calculated in advance, and the approximate volume of the expanded head is determined according to the diameter of the tubular pile 9 and the size, the material and the volume of the grouting bag 1, thereby determining the total amount of the grout that is required to be injected.

[0073] In the grouting, the grouting may be firstly performed into the second grouting pipe 3, and after the grout has filled the gap between the outer wall of the grouting bag 1 and the surrounding earth, injected between the outer wall of the tubular pile 9 and the surrounding disturbed soil zone, and upwardly returned by a certain height, subsequently the grouting is performed into the first grouting pipe 2. Optionally, the grouting into the second grouting pipe 3 and into the first grouting pipe 2 may be performed alternately. In other words, firstly a certain amount of the grout is injected into the second grouting pipe 3, subsequently a certain amount of the grout is injected into the first grouting pipe 2, subsequently a certain amount of the grout is injected into the second grouting pipe 3, and the steps are circulated and alternated accordingly.

[0074] The four step: the grout injected from the first grouting pipe 2 and the second grouting pipe 3 solidifying to form the expanded head.

[0075] As shown in FIG. 8, the grout injected from the first grouting pipe 2 and the second grouting pipe 3 solidifies after a duration, the grout outside the grouting bag 1 solidifies integrally with the surrounding earth and the bottom end of the tubular pile 9, and the grout inside the grouting bag 1 solidifies integrally with the grouting bag 1 and the grout outside the

grouting bag 1, to finally form the expanded head together. The volume of the expanded head is greater than the initial space between the pile body and the pile toe, thereby increasing the force bearing area of the bottom end of the tubular pile, and the expanded head solidifies integrally with the surrounding earth, thereby increasing the friction. Therefore, the single-pile bearing capacity of the tubular pile 9 is significantly increased.

[0076] Obviously, the above embodiments are merely examples taken for clear description, and are not limitation on the embodiments. A person skilled in the art may make other variations or alterations in various forms on the basis of the above description. The embodiments are not required to and cannot be exhaustively listed herein. The obvious variations or modifications that are made on that basis still fall within the protection scope of the present disclosure.

CLAIMS

1. A tubular-pile bottom-grouting device, wherein the device comprises:

a grouting bag (1), wherein the grouting bag (1) is inflatable when pushed by an internal
5 grout;

at least one first grouting pipe (2), wherein the first grouting pipe (2) is connected to the
grouting bag (1), and one end of the first grouting pipe (2) protrudes into the grouting bag (1);
and

at least one second grouting pipe (3), wherein the second grouting pipe (3) is connected to
10 the grouting bag (1), and the second grouting pipe (3) extends throughout the grouting bag (1).

2. The tubular-pile bottom-grouting device according to claim 1, wherein the grouting bag
(1) has openings at two ends, and a first connector (4) and a second connector (5) are provided at
the openings.

3. The tubular-pile bottom-grouting device according to claim 2, wherein first mounting
15 holes are provided in the first connector (4), a quantity of the first mounting holes is equal to a
sum of a quantity of the first grouting pipe (2) and a quantity of the second grouting pipe (3), a
second mounting hole is provided in the second connector (5), a quantity of the second mounting
hole is equal to the quantity of the second grouting pipe (3), one end of the first grouting pipe (2)
penetrates one instance of the first mounting holes and protrudes into the grouting bag (1), the
20 second grouting pipe (3) sequentially penetrates one instance of the first mounting holes and the
second mounting hole, and two ends of the second grouting pipe (3) are outside the grouting bag
(1).

4. The tubular-pile bottom-grouting device according to claim 3, wherein a plurality of
grouting holes (6) are provided in a side wall of a pipe section of the first grouting pipe (2) that is
25 located inside the grouting bag (1), and a plurality of grouting holes (6) are provided in a side
wall of a pipe section of one end of the second grouting pipe (3) that is outside the grouting bag
(1) and is closer to the second mounting hole.

5. The tubular-pile bottom-grouting device according to claim 4, wherein a one-way
grouting valve is outside the grouting holes (6).

6. The tubular-pile bottom-grouting device according to claim 2, wherein the openings of
30 the grouting bag (1) are connected to the first connector (4) and the second connector (5) by
fixers (7).

7. The tubular-pile bottom-grouting device according to any one of claims 2-6, wherein a
blocking plate (8) nests an exterior of the first connector (4).

8. The tubular-pile bottom-grouting device according to claim 7, wherein the blocking plate (8) has a flexible skirt edge.

9. A method for using a tubular-pile bottom-grouting device, applied to the tubular-pile bottom-grouting device according to any one of claims 1-8, wherein the method comprises the steps of:

providing the tubular-pile bottom-grouting device at a bottom of a tubular pile (9);

grouting into the second grouting pipe (3), to cause a grout to fill a gap between an outer wall of the grouting bag (1) and a surrounding earth, and grouting between an outer wall of the tubular pile (9) and a surrounding disturbed soil zone to form a grout lode;

grouting into the first grouting pipe (2), to cause the grouting bag (1) to inflate, and push the grout and the earth outside the grouting bag (1); and

the grout injected from the first grouting pipe (2) and the second grouting pipe (3) solidifying to form an expanded head.

10. The method for using a tubular-pile bottom-grouting device according to claim 9, wherein between the step of providing the tubular-pile bottom-grouting device at the bottom of the tubular pile (9) and the step of grouting into the second grouting pipe (3), to cause the grout to fill the gap between the outer wall of the grouting bag (1) and the surrounding earth, the method further comprises:

connecting a blocking plate (8) to an inner wall of a bottom end of the tubular pile (9), and injecting a cement slurry or a cement mortar to a top of the blocking plate (8).