

PILE END BOTTOM GROUTING APPARATUS, CAST-IN-PLACE PILE AND CONSTRUCTION METHOD THEREFOR

TECHNICAL FIELD

5 **[0001]** The disclosure relates to the technical field of foundation, in particular to a pile-end bottom grouting device, a cast-in-place pile and a construction method thereof.

BACKGROUND

10 **[0002]** At present, in a field of foundation, there are two main types of post end-grouting of cast-in-place piles, namely open grouting and closed grouting. The closed grouting mostly adopts steel capsule grouting, as described in the patent No. CN110896646B and titled "PILE BOTTOM GROUTING DEVICE AND APPLICATION METHOD THEREOF, AND CAST-IN-PLACE PILE BODY AND CONSTRUCTION METHOD THEREFOR", which involves a grouting capsule, a grouting pipe and a fixed plate. After the cast-in-place pile is
15 grouted, the grouting capsule is grouted through the grouting pipe to form an enlarged head at a bottom of the pile. However, the grouting capsule expands with increase of its pressure, and its relationship with a grouting pressure and a grouting quantity, as well as a volume of the enlarged head in a closed grouting cavity, is difficult to be controlled, which results in difficulty in controlling breaking timing and conditions of the grouting capsule, thus further affecting bearing
20 capacity of the cast-in-place pile.

SUMMARY

25 **[0003]** Therefore, a technical problem to be solved in this disclosure is to overcome a defect that it is difficult to control breaking timing and conditions of a grouting cavity in related art, so as to provide a pile-end bottom grouting device, a cast-in-place pile and a construction method thereof, which can accurately control the breaking timing and conditions of the grouting cavity.

30 **[0004]** In order to solve above technical problems, a pile-end bottom grouting device is provided in the disclosure, which includes:

35 **[0005]** a fixed plate; and

30 **[0006]** a grout storage bag fixed to the fixed plate, the grout storage bag forming an accommodating cavity suitable for accommodating grout or the grout storage bag and the fixed plate enclosing an accommodating cavity suitable for accommodating the grout, the grout storage bag having a filled state with the grout filled inside to bear a pile body and a furled state with a hollow interior, and the grout storage bag being preset with fixed ultimate bearing
35 strength and with a fixed volume in the filled state.

[0007] Alternatively, the grout storage bag is made of chemical synthetic fiber cloth or a plastic film.

[0008] Alternatively, the grout storage bag is provided with a weak area, and bearing strength of the weak area is smaller than that of other parts of the grout storage bag so as to form a grouting area when pressed.

[0009] Alternatively, the pile-end bottom grouting device further includes:

[0010] a grouting pipe communicated with an inner cavity of the grout storage bag and adapted to grouting into the grout storage bag; and

[0011] a first one-way valve provided at a communication position between the grouting pipe and the grout storage bag and adapted to preventing blockage in the grout storage bag from entering the grouting pipe.

[0012] Alternatively, a wall of the grouting pipe is provided with a first grout outlet, and the first one-way valve includes:

[0013] a first water-stop adhesive tape wound at a position where the grouting pipe is provided with the first grout outlet;

[0014] a first rubber sleeve being directly or indirectly sleeved outside the first water-stop adhesive tape;

[0015] the first water-stop adhesive tape and the first rubber sleeve having a sealed state of tightening in a direction towards the grouting pipe, and an open state of forming a gap with the grouting pipe under a pressure of the grouting pipe; and

[0016] a first hard sheet sandwiched between the first water-stop adhesive tape and the first rubber sleeve and provided corresponding to the first grout outlet.

[0017] Alternatively, the grouting pipe includes:

[0018] a first grout discharging part located in the inner cavity of the grout storage bag;

[0019] an interface passing through the fixed plate and communicated with the first grout discharging part; and

[0020] a grout inlet pipe in sealed communication with the interface.

[0021] Alternatively, the fixed plate is an annular plate, and the grout storage bag is an annular structure adapted to the annular plate.

[0022] Alternatively, an edge of an inner ring of the fixed plate is provided with an annular stopper extending to an inner ring of the grout storage bag.

[0023] Alternatively, the pile-end bottom grouting device further includes:

[0024] a grout supply pipe communicated with an inner area of the annular stopper and adapted to grouting into a pile hole; and

[0025] a second one-way valve provided at a communication position between the grout supply pipe and the inner area of the annular stopper, and adapted to preventing blockage in the pile hole from entering the grout supply pipe.

[0026] Alternatively, a second grout outlet is provided on a wall of the grout supply pipe, and the second one-way valve includes:

[0027] a second water-stop adhesive tape wound at a position where the grout supply pipe is provided with the second grout outlet;

[0028] a second rubber sleeve directly or indirectly sleeved outside the second water-stop adhesive tape;

[0029] the second water-stop adhesive tape and the second rubber sleeve both having a sealed state of tightening in a direction towards the grout supply pipe, and an open state of forming a gap with the grout supply pipe under a pressure of the grout supply pipe; and

[0030] a second hard sheet sandwiched between the second water-stop adhesive tape and the second rubber sleeve and provided corresponding to the second grout outlet.

[0031] Alternatively, the grout supply pipe is provided with a second grout discharging part extending to the inner area of the annular stopper, and the second grout discharging part is an annular pipeline extending along an inner wall of the annular stopper.

[0032] Alternatively, the fixed plate is provided with a detection port, and the detection port is adapted to filling medium into the grout storage bag.

[0033] Alternatively, the pile-end bottom grouting device further includes:

[0034] a protective cover detachably connected with the fixed plate and adapted to being covered outside the grout storage bag before construction.

[0035] A cast-in-place pile is further provided in the disclosure, which includes:

[0036] the pile-end bottom grouting device described above; and

[0037] a steel cage connected with the fixed plate of the pile-end bottom grouting device.

[0038] A construction method of the cast-in-place pile is further provided in the disclosure, which sequentially includes following steps:

[0039] S1, forming a pile hole and cleaning sediment in the pile hole;

[0040] S2, sinking the steel cage with the pile-end bottom grouting device mounted at a bottom end to a bottom of the pile hole;

[0041] S3, grouting concrete into the pile hole to form a cast-in-place pile; and

[0042] S4, grouting into the grout storage bag to form an enlarged head at a bottom of the pile.

[0043] Alternatively, step S4 is controlled according to properties of soil forming the pile hole. If the soil is sandy soil, an actual grouting quantity and a grouting pressure are controlled to be greater than preset values of the grout storage bag to cause the grout storage bag to be broken;

and if the soil is cohesive soil, the actual grouting quantity and the grouting pressure are controlled to be less than the preset values of the grout storage bag to avoid the grout storage bag from being broken.

[0044] Technical schemes of the disclosure have following advantages:

5 **[0045]** 1. For the pile-end bottom grouting device according to this disclosure, an existing grouting capsule is replaced with the grout storage bag, which has a fixed volume in the filled state and cannot expand with increase in an internal pressure, with a preset fixed limit bearing strength value. In actual grouting, if it needs to be broken, the actual grouting quantity and grouting pressure can be controlled to be greater than the preset values of the grout storage bag; 10 and if it is not necessary to be broken, the actual grouting quantity and the grouting pressure can be controlled to be less than the preset values of the grout storage bag. In this way, the breaking timing and conditions of the grout storage bag can be accurately controlled, thus more accurately controlling the volume and shape of the enlarged head at the bottom of the pile, controlling a grouting process and grouting effect, and finally effectively eliminating settlement at the bottom 15 of the pile, greatly improving ultimate bearing capacity of the cast-in-place pile and reducing project cost.

[0046] 2. The pile-end bottom grouting device according to this disclosure is provided with a weak area on the grout storage bag, and the bearing strength of the weak area is smaller than that of other parts of the grout storage bag. In actual grouting, the weak area may be pressed and 20 firstly crushed to form a grouting area. In this way, the weak area can be arranged at different parts of the grout storage bag, or the weak area can be arranged in different shapes to meet needs of different construction scenes.

[0047] 3. The pile-end bottom grouting device according to this disclosure is designed with a specific one-way valve structure including a water-stop adhesive tape, a hard sheet and a rubber 25 sleeve, in view of a fact that the grout outlet is opened on the pipe wall. When a pressure in the pipe is greater than the ultimate bearing strength of the water-stop adhesive tape, the water-stop adhesive tape moves away from the pipe wall under action of the pressure in the pipe, so that a grouting gap is formed between the water-stop adhesive tape and the pipe wall, and the pressure in the pipe overcomes an elastic force of the rubber sleeve at the same time, so that it follows the 30 water-stop adhesive tape into the open state to complete grouting; and when the pressure in the pipe is less than or equal to the ultimate bearing strength of the water-stop adhesive tape, the pressure in the pipe is not enough to open the water-stop adhesive tape, and the water-stop adhesive tape is abutted against the pipe wall tightly under the elastic force of the rubber sleeve, and the rubber sleeve turns into a sealed state in which the grout outside the pipe can be 35 prevented from flowing back into the pipe, thus functioning as the one-way valve. In addition,

the hard sheet can prevent the rubber sleeve from being partially sucked into the pipe through the grout outlet due to a negative pressure, resulting in deterioration in sealing performance.

[0048] 4. In the pile-end bottom grouting device according to this disclosure, the fixed plate is set as the annular plate, so that in a process of sinking the whole device along the pile hole, muddy water, air and others in the pile hole may pass through the hole and thus enter to be above the pile bottom grouting device, and no vortex damaging the hole wall can be formed between the pile bottom grouting device and the pile hole, thus effectively avoiding a problem that the vortex damaging the hole wall can be formed in the pile hole during a descending process because the muddy water cannot be discharged, avoiding a muddy water flow swirling between the edge of the fixed plate and the pile hole from scouring and disturbing a wall of the pile hole, effectively preventing the wall of the pile hole from collapsing, sediment at the bottom of the hole from exceeding its standard and the pile from being broken, and effectively improving construction quality and progress of a cast-in-place pile body.

[0049] 5. The cast-in-place pile according to this disclosure has advantages of any one of the above schemes because it has the pile-end bottom grouting device described in any one of the above schemes.

[0050] 6. For the construction method according to the disclosure, the actual grouting quantity and grouting pressure can be determined according to soil properties in combination with preset capacity and preset ultimate bearing strength of the grout storage bag, so as to accurately control the breaking timing and conditions for the grout storage bag, further accurately control the shape and volume of the enlarged head and ensure sufficient bearing capacity.

BRIEF DESCRIPTION OF THE DRAWINGS

[0051] In order to explain specific embodiments of the present disclosure or the technical schemes in the related art more clearly, the drawings required in the description of the specific embodiments or the related art will be briefly introduced below; obviously, the drawings in the following description are only some implementations of the present disclosure, and other drawings can be obtained according to these drawings by those of ordinary skilled in the art without paying creative labor.

[0052] FIG. 1 is a schematic diagram of an implementation structure of a pile-end bottom grouting device according to the disclosure;

[0053] FIG. 2 is a schematic diagram of another implementation structure of a pile-end bottom grouting device according to the disclosure;

[0054] FIG. 3 is a schematic top view of a pile-end bottom grouting device according to the disclosure;

[0055] FIG. 4 is a schematic structural diagram of an one-way valve according to the disclosure;

[0056] FIG. 5 is a schematic structural diagram of a cast-in-place pile according to the disclosure;

5 **[0057]** FIG. 6 is a schematic diagram showing a structure of a grout supply pipe according to the disclosure; and

[0058] FIG. 7 is a top view of a polygonal grout storage bag according to the present disclosure.

[0059] Description of reference numerals:

10 **[0060]** 1. Fixed plate; 2. Grout storage bag; 21. Detection Port; 3. Grouting Pipe; 31. First Grout Discharging Part; 311. First Grout Outlet; 32. Interface; 33. Grout Inlet Pipe; 4. First One-way Valve; 41. First Water-stop Adhesive Tape; 42. First Rubber Sleeve; 43. First Hard Sheet; 5. Annular Stopper; 6. Grout Supply Pipe; 61. Second Grout Discharging Part; 611. Second Grout Outlet; 7. Second One-way Valve; 71. Second Water-stop Adhesive Tape; 72.
15 Second Rubber Sleeve; 73. Second Hard Sheet; 8. Steel Cage.

DETAILED DESCRIPTION

[0061] In the following, technical schemes in the disclosure will be described clearly and completely in connection with the attached drawings; obviously, the described embodiments are
20 intended to be a part of the embodiment of the disclosure, but not all of them. On a basis of the embodiments in this disclosure, all other embodiments obtained by the ordinary skilled in the art without any creative effort should be within a protection scope of this disclosure.

[0062] In the description of this disclosure, it should be noted that unless otherwise specified and limited, the terms “mounting”, “coupling” and “connecting” should be understood in a broad
25 sense, for example, it can be “fixedly connecting”, or “detachably connecting” or “integrally connecting”, or it can be “mechanically connecting” or “electrically connecting”, or it can be “directly connecting” or “indirectly connecting through an intermediate medium”, or it can be “communicating within two elements”. For those ordinary skilled in the art, the specific meanings of the above terms in this disclosure can be understood according to specific situations.

30 **[0063]** In addition, technical features involved in different embodiments of the disclosure described below can be combined with each other as long as they do not conflict with each other.

[0064] A pile-end bottom grouting device is provided in the disclosure, which, referring to FIGS. 1 to 3, includes a fixed plate 1 and a grout storage bag 2 specifically as follows.

[0065] The fixed plate 1 can be made of a metal or high-strength plastic plate, hard silica gel
35 or other commonly used materials with hardness that can meet use requirements. The fixed plate

1 can be manufactured and integrally formed by conventional machining or 3D printing. A shape of the fixed plate 1 is not limited, and the shape of the fixed plate 1 is determined according to a cross-sectional shape of a pile hole.

[0066] The grout storage bag 2 is fixed to the fixed plate 1, and the grout storage bag 2 forms an accommodating cavity suitable for accommodating grout or the grout storage bag 2 and the fixed plate 1 enclose an accommodating cavity suitable for accommodating the grout. The grout storage bag 2 can be a separate entirety and then fixed to the fixed plate 1; and it can also be of an open structure, which is then sealingly connected with the fixed plate 1 to form the accommodating cavity. The grout storage bag 2 can be spherical (as shown in FIG. 2), rectangular (as shown in FIG. 1), polygonal (as shown in FIG. 7) or other common shapes after being filled, and it is easy for the skilled in the art to determine the shape of the grout storage bag 2 after being filled according to the cross-sectional shape of the pile hole. The grout storage bag 2 may have a symmetrical structure or an asymmetrical structure. The grout storage bag 2 can be integrally formed by knitting, weaving, blowing and pressing. It can also be tailored and shaped by sewing, adhesion and other methods. Connection between the grout storage bag 2 and the fixed plate 1 can be as follows: a groove is formed at an edge of the fixed plate 1, a pinhole is provided in the groove, an edge of the grout storage bag 2 is placed in the groove, and the grout storage bag 2 is bound to the fixed plate 1 by sewing technology using the groove and the pinhole. Of course, the grout storage bag 2 and the fixed plate 1 can also be connected by rivets, chemical bonding or other common connection methods. The grout storage bag 2 has a filled state with the grout filled inside to bear a pile body and a furled state with a hollow interior, and the grout storage bag 2 is preset with fixed ultimate bearing strength and with a fixed volume in the filled state. The so-called filled state herein is a state in which the grout storage bag 2 is fully filled with the grout with a braced skin; and the furled state refers to a state in which the grout storage bag is not filled with the grout or not fully filled with the grout with a skin not fully braced. An expression "fixed volume in the filled state" refers that the grout storage bag has no elastic expansion, with a volume fixed after the grout is filled, which is mainly described relative to a grouting capsule in the related art. When an existing grouting capsule is in a filled state, it may continue to expanding with increase in a pressure in inside the grouting capsule, and the volume of the grout storage bag 2 in this disclosure is fixed in the filled state. An expression "the preset fixed bearing strength" means that it is designed that the bearing strength of the grout storage bag 2 when it is broken under a pressure is fixed. The existing grouting capsule becomes larger with the increase in the pressure inside the grouting capsule, and it is easy to be disturbed by a wall of the pile hole outside after expansion, so the bearing strength when it is broken is not fixed.

[0067] In the pile-end bottom grouting device, the grout storage bag 2 with a constant volume in the filled state is adopted, and the ultimate bearing strength and volume of the grout storage bag 2 are set, which do not change constantly like the existing grouting capsule, so an actual grouting pressure and grouting quantity can be determined according to the preset ultimate volume and ultimate bearing strength of the grout storage bag 2, so as to accurately control the breaking timing and conditions of the grout storage bag 2.

[0068] Preferably, the grout storage bag 2 can be made of chemical synthetic fiber cloth, such as polyester, nylon, acrylic fiber, etc.; or of a plastic film, such as polyvinyl chloride, polyethylene, polypropylene films, etc. Specifically, strength of the plastic film and chemical synthetic fiber can meet requirements of filling concrete grout, which is the most basic knowledge known to those skilled in the art. Of course, in other embodiments, the grout storage bag 2 can also be made of other common materials, but it must be suitable for accommodating concrete grout and have a fixed volume in a filled state. Specifically, the grout storage bag 2 can be of a single layer or of a multi-layer structure.

[0069] As a further improvement, the grout storage bag 2 is provided with a weak area, and bearing strength of the weak area is smaller than that of other parts of the grout storage bag 2 to form a grouting area when pressed. The weak area can be strip-shaped, circular or in any other shape, which is mainly determined by a form of bursting grout.

[0070] In this way, the disclosure has following effects: provision of the weak area can more accurately control a specific position where and a form in which the grout storage bag 2 burst the grout, thus further improving controllability of breaking of the grout storage bag 2 and meeting demands of various construction scenes.

[0071] Of course, in other embodiments, the grout storage bag 2 can also be uniform, that is, with no weak area.

[0072] As a further improvement, referring to FIGS. 1 and 2, the pile-end bottom grouting device further includes:

[0073] a grouting pipe 3 communicated with an inner cavity of the grout storage bag 2 and adapted to grouting into the grout storage bag 2; and

[0074] a first one-way valve 4 provided at a communication position between the grouting pipe 3 and the grout storage bag 2 and adopted preventing blockage in the grout storage bag 2 from entering the grouting pipe 3.

[0075] In this way, the disclosure has following effects: provision of the first one-way valve 4 can ensure normal output of the grout, and at the same time, it can also prevent external silt, sediment and other blockages from entering the grouting pipe 3.

[0076] Preferably, referring to FIG. 4, a wall of the grouting pipe 3 is provided with a first grout outlet 311, and the first one-way valve 4 includes: a first water-stop adhesive tape 41, a first rubber sleeve 42 and a first hard sheet 43.

[0077] The first water-stop adhesive tape 41 is wound at a position where the grouting pipe 3 is provided with the first grout outlet 311.

[0078] The first rubber sleeve 42 is directly sleeved outside the first water-stop adhesive tape 41, and the first rubber sleeve 42 is made of elastic materials such as rubber or soft silica gel.

[0079] The first water-stop adhesive tape 41 and the first rubber sleeve 42 both have a sealed state of tightening in a direction towards the grouting pipe 3, and an open state of forming a gap with the grouting pipe 3 under a pressure of the grouting pipe 3. In the sealed state, the first water-stop adhesive tape 41 is abutted against the grouting pipe 3 under tightening action of the first rubber sleeve 42, and in the open state, a gap is formed between the first water-stop adhesive tape 41 and the grouting pipe 3, through which the grout inside the grouting pipe 3 can be discharged.

[0080] The first hard sheet 43 is sandwiched between the first water-stop adhesive tape 41 and the first rubber sleeve 42 and provided corresponding to the first grout outlet 311. The first hard sheet 43 is made of a metal sheet, hard plastic or other hard materials.

[0081] In this way, the disclosure has following effects: the first water-stop adhesive tape 41 has good water-stop effect, which can improve sealing performance of the one-way valve; the first rubber sleeve 42 has good elasticity, which on the one hand can ensure resetting of the first water-stop adhesive tape 41, and on the other hand can also provide a sufficient tightening force to ensure that the first water-stop adhesive tape 41 is closely adhered to the wall of the grouting pipe 3 in the sealed state; and the first hard sheet 43 is relatively high in hardness, which can overcome a negative pressure and prevent the flexible first rubber sleeve 42 and the first water-stop adhesive tape 41 from being partially sucked into the pipe through the first grout outlet 311, resulting in structural damage and deterioration in sealing performance.

[0082] As an improved structure of the above technical scheme, a layer of rubber sleeve can be added between the first water-stop adhesive tape 41 and the first hard sheet 43, that is, the first rubber sleeve 42 is indirectly sleeved on the first water-stop adhesive tape 41 through the added rubber sleeve, so that compared with the above structure, the first water-stop adhesive tape 41 is completely contacted with the added rubber sleeve, and the rubber sleeve has better locking effect on the first water-stop adhesive tape 41.

[0083] Preferably, referring to FIGS. 1 to 3, the grouting pipe 3 includes: a first grout discharging part 31, an interface 32 and a grout inlet pipe 33.

[0084] The first grout discharging part 31 is located in the inner cavity of the grout storage bag 2. A shape of the first grout discharging part 31 can be determined according to a shape of the grout storage bag 2. For example, if the grout storage bag 2 has an annular structure, the first grout discharging part 31 should be correspondingly designed as an annular pipe adapted to the grout storage bag 2, so that it can extend to different parts of the grout storage bag 2 and make grouting more uniform.

[0085] The interface 32 passes through the fixed plate 1 and is communicated with the first grout discharging part 31.

[0086] The grout inlet pipe 33 is in sealed communication with the interface 32.

[0087] Connection between the interface 32 and the grout inlet pipe 33 can be threaded connection, flanged connection, welding connection, socket connection or pipe bonding connection.

[0088] In this way, the disclosure has following effects: in grouting, the grout enters from the grout inlet pipe 33 and reaches the first grout discharging part 31 through the interface 32, thus entering the grout storage bag 2, which facilitates grouting.

[0089] Preferably, referring to FIG. 3, the fixed plate 1 is an annular plate, and the grout storage bag 2 is an annular structure adapted to the annular plate. An expression "annular" herein preferably refers to a ring, but it is not limited to the ring. A specific shape of the ring is determined according to a shape of the pile hole. For example, if the pile hole is square, a square ring structure is adopted. A position of an "annular" inner hole is preferably a central position where it is coaxial with an annular outer edge, but it is not limited to this position, and it can also be arranged eccentrically.

[0090] In this way, the disclosure has following effects: the fixed plate 1 and the grout storage bag 2 are annular so that in a process of sinking the pile-end bottom grouting device towards a bottom of the pile hole, muddy water, air and others in the pile hole enter to be above the pile-end bottom grouting device through the annular inner hole, and no vortex damaging the hole wall can be formed between the pile-end bottom grouting device and the pile hole, thus effectively avoiding a problem that the vortex damaging the hole wall can be formed in the pile hole during a descending process of the pile-end bottom grouting device because the muddy water cannot be discharged, avoiding a muddy water flow swirling between the edge of the fixed plate 1 and the pile hole from scouring and disturbing a hole wall, effectively preventing the wall of the pile hole from collapsing, sediment at the bottom of the hole from exceeding its standard and the pile from being broken, and effectively improving construction quality and progress of a cast-in-place pile.

[0091] As a further improvement, referring to FIGS. 1 and 2, an edge of an inner ring of the fixed plate 1 is provided with an annular stopper 5 extending to an inner ring of the grout storage bag 2. The fixed plate can be made of a metal or high-strength plastic plate, hard silica gel or other commonly used materials with hardness that can meet use requirements. The annular stopper 5 can be fixed to the edge of an inner ring of the fixed plate 1; or can be integrally formed with the fixed plate 1. When the grout storage bag 2 is of an open structure, the grout storage bag 2 can be sealingly connected with the fixed plate 1 and the annular stopper 5 at the same time to form an accommodating cavity. Connection between the grout storage bag 2 and the annular stopper 5 can be as follows: a groove is formed at an edge of the annular stopper 5, a pinhole is provided in the groove, an edge of the grout storage bag 2 is placed in the groove, and the grout storage bag 2 is bound to the annular stopper 5 by sewing technology using the groove and the pinhole. Of course, the grout storage bag 2 and the annular stopper 5 can also be connected by rivets, chemical bonding or other common connection methods.

[0092] In this way, the disclosure has following effects: during construction of the cast-in-place pile, concrete needs to be grouted into a steel cage 8 mounted with the pile-end bottom grouting device to form the cast-in-place pile, and the annular stopper 5 can effectively form a stopper separating the concrete from the grout storage bag 2 at the edge of the hole, so as to prevent a problem that the concrete wraps the grout storage bag 2 through the inner hole of the fixed plate 1 in grouting the concrete into the steel cage 8, and avoid a problem that the grout storage bag 2 is wrapped by the concrete and grouting effect of the cast-in-place pile is affected.

[0093] As a further improvement, referring to FIGS. 1 and 2, the pile-end bottom grouting device further includes: a grout supply pipe 6 and a second one-way valve 7.

[0094] The grout supply pipe 6 is communicated with an inner area of the annular stopper 5 and adapted to grouting into a pile hole.

[0095] The second one-way valve 7 is provided at a communication position between the grout supply pipe 6 and the inner area of the annular stopper 5, and adapted to preventing blockage in the pile hole from entering the grout supply pipe 6.

[0096] In this way, the disclosure has following effects: the grouting pipe 6 can simply and conveniently grout into the inner area of the annular stopper 5, so as to eliminate a virtual tip and dry ballast formed by concrete disintegration at a bottom of the pile due to too large drop, and effectively fill the inner area of the annular stopper 5, thereby enhancing strength of the bottom of the pile. Provision of the second one-way valve 7 can ensure normal output of the grout, and at the same time, it can also prevent external silt, sediment and other blockages from entering the grouting pipe 3.

[0097] Preferably, referring to FIG. 4, a wall of the grout supply pipe 6 is provided with a second grout outlet 611, and the second one-way valve 7 includes: a second water-stop adhesive tape 71, a second rubber sleeve 72 and a second hard sheet 73.

[0098] The second water-stop adhesive tape 71 is wound at a position where the grout supply pipe 6 is provided with the second grout outlet 611.

[0099] The second rubber sleeve 72 is directly sleeved outside the second water-stop adhesive tape 71, and the second rubber sleeve 72 is made of elastic materials such as rubber or soft silica gel.

[00100] The second water-stop adhesive tape 71 and the second rubber sleeve 72 both have a sealed state of tightening in a direction towards the grout supply pipe 6, and an open state of forming a gap with the grout supply pipe 6 under a pressure of the grout supply pipe 6. In the sealed state, the second water-stop adhesive tape 71 is abutted against the grout supply pipe 6 under tightening action of the first rubber sleeve 72, and in the open state, a gap is formed between the second water-stop adhesive tape 71 and the grout supply pipe 6, through which the grout inside the grout supply pipe 6 can be discharged.

[00101] The second hard sheet 73 is sandwiched between the second water-stop adhesive tape 71 and the second rubber sleeve 72 and provided corresponding to the second grout outlet 611. The second hard sheet 43 is made of a metal sheet, hard plastic or other hard materials.

[00102] In this way, the disclosure has following effects: the second water-stop adhesive tape 71 has good water-stop effect, which can improve sealing performance of the one-way valve; the second rubber sleeve 72 has good elasticity, which on the one hand can ensure resetting of the second water-stop adhesive tape 71, and on the other hand can also provide a sufficient tightening force to ensure that the second water-stop adhesive tape 71 is closely adhered to the wall of the grout supply pipe 6 in the sealed state; and the second hard sheet 73 is relatively high in hardness, which can overcome a negative pressure and prevent the flexible second rubber sleeve 72 and the second water-stop adhesive tape 71 from being partially sucked into the pipe through the second grout outlet 611, resulting in structural damage and deterioration in sealing performance.

[00103] As an improved structure of the above technical scheme, a layer of rubber sleeve can be added between the second water-stop adhesive tape 71 and the second hard sheet 73, that is, the second rubber sleeve 72 is indirectly sleeved on the second water-stop adhesive tape 71 through the added rubber sleeve, so that compared with the above structure, the second water-stop adhesive tape 71 is completely contacted with the added rubber sleeve, and the rubber sleeve has better locking effect on the second water-stop adhesive tape 71.

[00104] Preferably, referring to FIGS. 1 and 2, the grout supply pipe 6 is provided with a second grout discharging part 61 extending to the inner area of the annular stopper 5, and the second grout discharging part 61 is an annular pipeline extending along an inner wall of the annular stopper 5. Of course, in other embodiments, the grout supply pipe 6 can also be of a single pipe structure, as shown in FIG. 6; or can be two pipes and of other easily conceivable alternative structures.

[00105] In this way, the disclosure has the following effects: the second grout discharging part 61 is arranged as an annular pipeline, which can be better adapted to the inner area of the annular stopper 5 and transport the grout to different positions in the inner area, with more uniform grout supplying.

[00106] As a further improvement of the above technical scheme, referring to FIGS. 1 and 2, the fixed plate 1 is provided with a detection port 21, which is adapted to filling medium into the grout storage bag 2 to verify whether the grout storage bag 2 leaks and/or to verify a pressure it can bear.

[00107] In this way, the disclosure has following effects: with provision of the detection port 21, an ultimate volume and ultimate bearing strength of the grout storage bag 2 can be obtained through experiments, which facilitates to obtaining more accurate preset values, thus facilitating accurate control of breaking timing and conditions of the grout storage bag 2 in subsequent construction.

[00108] As a further improvement of the above technical scheme, the pile-end bottom grouting device further includes a protective cover.

[00109] The protective cover is detachably connected with the fixed plate 1 and adapted to being covered outside the grout storage bag 2 before construction. The protective cover can be made of aluminum foil, hard plastic or hard silica gel, etc., which is mainly configured to protect the grout storage bag 2 before construction so as to avoid bumping of and damage to the grout storage bag 2; and during the construction, the protective cover needs to be removed from the fixed plate 1.

[00110] A cast-in-place pile is further provided in the disclosure, which, referring to FIG. 5, includes the pile-end bottom grouting device described above and a steel cage 8. The steel cage 8 is connected with the fixed plate 1 of the pile-end bottom grouting device.

[00111] In a specific implementation, the grout inlet pipe 33 and the grout supply pipe 6 can be fixedly connected with the steel cage 8 so as to realize fixation.

[00112] In detail, the fixed plate 1, the grouting pipe 3, the annular stopper 5 and the grout supply pipe 6 in this disclosure can all be made of high-strength plastics. Specifically, they can be one-step formed by injection molding or 3D printing.

[00113] The cast-in-place pile in the disclosure has effect of any one of the pile-end bottom grouting devices described above because it has the pile-end bottom grouting device.

[00114] A construction method of the cast-in-place pile is further provided in the disclosure, which sequentially includes following steps:

5 **[00115]** S1, forming a pile hole and cleaning sediment in the pile hole;

[00116] S2, sinking the steel cage 8 with the pile-end bottom grouting device mounted at a bottom end to a bottom of the pile hole;

[00117] S3, grouting concrete into the pile hole to form a cast-in-place pile; and

[00118] S4, grouting into a grout storage bag 2 to form an enlarged head at a bottom of the pile.

10 **[00119]** Step S4 is controlled according to properties of soil forming the pile hole. If the soil is sandy soil, an actual grouting quantity and grouting pressure should be controlled to be greater than preset values of the grout storage bag 2 (there are two preset values: one is a volume value of the grout storage bag 2 in the filled state designed in making the grout storage bag 2, and the other is a preset fixed bearing strength value), so as to cause the grout storage bag 2 to be broken,
15 and thus cement grout in the grout storage bag 2 spills, which infiltrates and consolidates the sandy soil around the bottom of the pile, and the enlarged head at the pile end is tightly bonded to surrounding strata as a whole. If the soil is cohesive soil, the actual grouting quantity and the grouting pressure are controlled to be less than the preset values of the grout storage bag 2 so as to avoid the grout storage bag 2 from being broken. In use, the enlarged head formed at a bottom
20 of a pile end should be as large as possible by controlling the grouting pressure and the grouting quantity, thus greatly improving the ultimate bearing capacity of the cast-in-place pile and reducing settlement. Subsequently, the grout supply pipe 6 in the grouting device can directly grout into the stratum at the bottom of the pile. At this time, the formed enlarged head can prevent the grout from flowing upward back, promote development of grouting into the stratum,
25 and expand a reinforcement scope of foundation at the bottom of the pile. Of course, in other embodiments, if the soil is sandy soil, the grout storage bag 2 can also be controlled not to be broken; and if the soil is cohesive soil, the grout storage bag 2 can also be controlled to be broken.

[00120] In this way, the disclosure has following effects: in the construction method in this
30 disclosure, the unique pile-end bottom grouting device described above is used to accurately select whether the grout storage bag is broken and breaking timing and conditions according to different soil properties and the preset value of the grout storage bag 2, so as to adaptively improve the bearing capacity of the cast-in-place pile.

[00121] Obviously, the above embodiments are only examples for clear explanation, and is not
35 intended to limit implementations. For those skilled in the art, other changes or variations in

different forms can be made on a basis of the above description. It is not necessary and impossible to exhaust all of embodiments here. However, obvious changes or variations caused by this are still within the scope of protection created by the present disclosure.

CLAIMS

1. A pile-end bottom grouting device, comprising:

a fixed plate (1); and

5 further comprising: a grout storage bag (2) fixed to the fixed plate (1), the grout storage bag (2) forming an accommodating cavity suitable for accommodating grout or the grout storage bag (2) and the fixed plate (1) enclosing an accommodating cavity suitable for accommodating the grout, the grout storage bag (2) having a filled state with the grout filled inside to bear a pile body and a furled state with a hollow interior, and the grout storage bag (2) being preset with
10 fixed ultimate bearing strength and with a fixed volume in the filled state.

2. The pile-end bottom grouting device according to claim 1, wherein the grout storage bag (2) is made of chemical synthetic fiber cloth or a plastic film.

3. The pile-end bottom grouting device according to claim 1 or 2, wherein the grout storage bag (2) is provided with a weak area, bearing strength of the weak area being smaller than
15 bearing strength of other parts of the grout storage bag (2) to form a grouting area when pressed.

4. The pile-end bottom grouting device according to claim 1, further comprising:

a grouting pipe (3) communicated with an inner cavity of the grout storage bag (2) and adapted to grouting into the grout storage bag (2); and

a first one-way valve (4) provided at a communication position between the grouting pipe (3) and the grout storage bag (2) and adopted to preventing blockage in the grout storage bag (2) from entering the grouting pipe (3).
20

5. The pile-end bottom grouting device according to claim 4, wherein a wall of the grouting pipe (3) is provided with a first grout outlet (311), and the first one-way valve (4) comprises:

a first water-stop adhesive tape (41) wound at a position where the grouting pipe (3) is
25 provided with the first grout outlet (311);

a first rubber sleeve (42) being directly or indirectly sleeved outside the first water-stop adhesive tape (41); the first water-stop adhesive tape (41) and the first rubber sleeve (42) having a sealed state of tightening in a direction towards the grouting pipe (3), and an open state of forming a gap with the grouting pipe (3) under a pressure of the grouting pipe (3); and

30 a first hard sheet (43) sandwiched between the first water-stop adhesive tape (41) and the first rubber sleeve (42) and provided corresponding to the first grout outlet (311).

6. The pile-end bottom grouting device according to claim 4 or 5, wherein the grouting pipe (3) comprises:

a first grout discharging part (31) located in the inner cavity of the grout storage bag (2);

an interface (32) passing through the fixed plate (1) and communicated with the first grout discharging part (31); and

a grout inlet pipe (33) in sealed communication with the interface (32).

5 7.The pile-end bottom grouting device according to claim 1, wherein the fixed plate (1) is an annular plate, and the grout storage bag (2) is an annular structure adapted to the annular plate.

8.The pile-end bottom grouting device according to claim 7, wherein an edge of an inner ring of the fixed plate (1) is provided with an annular stopper (5) extending to an inner ring of the grout storage bag (2).

10 9.The pile-end bottom grouting device according to claim 8, further comprising:
a grout supply pipe (6) communicated with an inner area of the annular stopper (5) and adapted to grouting into a pile hole; and

a second one-way valve (7) provided at a communication position between the grout supply pipe (6) and the inner area of the annular stopper (5), and adapted to preventing blockage in the
15 pile hole from entering the grout supply pipe (6).

10.The pile-end bottom grouting device according to claim 9, wherein a second grout outlet (611) is provided on a wall of the grout supply pipe (6), and the second one-way valve (7) comprises:

a second water-stop adhesive tape (71) wound at a position where the grout supply pipe (6)
20 is provided with the second grout outlet (611);

a second rubber sleeve (72) directly or indirectly sleeved outside the second water-stop adhesive tape (71); the second water-stop adhesive tape (71) and the second rubber sleeve (72) both having a sealed state of tightening in a direction towards the grout supply pipe (6), and an open state of forming a gap with the grout supply pipe (6) under a pressure of the grout supply
25 pipe (6); and

a second hard sheet (73) sandwiched between the second water-stop adhesive tape (71) and the second rubber sleeve (72) and provided corresponding to the second grout outlet (611).

11.The pile-end bottom grouting device according to claim 9 or 10, wherein the grout supply pipe (6) is provided with a second grout discharging part (61) extending to the inner area
30 of the annular stopper (5), the second grout discharging part (61) being an annular pipeline extending along an inner wall of the annular stopper (5).

12.The pile-end bottom grouting device according to claim 1, wherein the fixed plate (1) is provided with a detection port (21), the detection port (21) being adapted to filling medium into the grout storage bag (2).

35 13.The pile-end bottom grouting device according to claim 1, further comprising:

a protective cover detachably connected with the fixed plate (1) and adapted to being covered outside the grout storage bag (2) before construction.

14.A cast-in-place pile, comprising:

the pile-end bottom grouting device according to any one of claims 1-13; and

5 a steel cage (8) connected with the fixed plate (1) of the pile-end bottom grouting device.

15.A construction method of the cast-in-place pile according to claim 14, comprising:

S1, forming a pile hole and cleaning sediment in the pile hole;

S2, sinking the steel cage (8) with the pile-end bottom grouting device mounted at a bottom end to a bottom of the pile hole;

10 S3, grouting concrete into the pile hole to form a cast-in-place pile; and

S4, grouting into a grout storage bag (2) to form an enlarged head at a bottom of the pile.

16.The construction method according to claim 15, wherein step S4 is controlled according to properties of soil forming the pile hole, and if the soil is sandy soil, an actual grouting quantity and a grouting pressure are controlled to be greater than preset values of the grout storage bag (2),

15 to cause the grout storage bag (2) to be broken; and if the soil is cohesive soil, the actual grouting quantity and the grouting pressure are controlled to be less than the preset values of the grout storage bag (2) to avoid the grout storage bag (2) from being broken.