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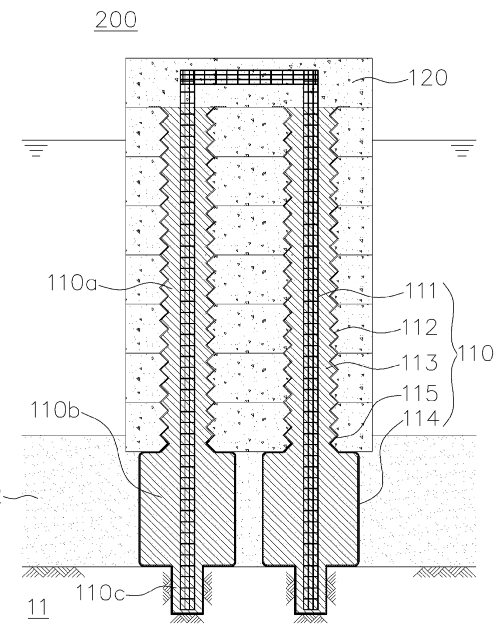
(54) **UNDERWATER CONCRETE STRUCTURE FOR PREVENTING SUBSIDENCE AT SEABED SOFT GROUND, AND CONSTRUCTION METHOD THEREFOR**

(57) The present invention has concrete columns formed along a vertical penetration hole of a main concrete structure, seabed soft ground and seabed rock, wherein the concrete column formed in the seabed soft ground supports the lower end of the main concrete structure while having a diameter larger than the diameter of the concrete column formed in the vertical penetration hole, thereby preventing the main concrete structure from subsiding in the seabed soft ground.

【Fig.14】



Description

Technical Field

[0001] The present disclosure relates to an underwater concrete structure capable of preventing subsidence in seabed soft ground and a construction method therefor and, particularly, to an underwater concrete structure and a construction method thereof, in which concrete columns are capable of supporting the lower end of a main concrete structure to prevent the main concrete structure from subsiding in seabed soft ground.

Background Art

[0002] An underwater structure, such as berthing facilities for ports, coastal wave-dissipating structures, and breakwaters, are installed underwater for various purposes. As used above and below, the term "underwater structure" refers to an underwater structure installed with a lower part thereof submerged in water, and an upper part thereof may protrude above the water surface or be located below the water surface.

[0003] A widely known construction technique in the construction of an underwater structure is the construction method of a large caisson. The large caisson construction method has the advantage of allowing a very large caisson to withstand large waves, but requires manufacturing the very large caisson on land, transporting it to an installation site, and then installing it underwater, so the large caisson construction method requires very high transportation and construction costs and has many restrictions.

[0004] In order to solve the problems of this type of large caisson construction method, a method of forming an underwater structure by stacking small concrete blocks in several layers according to the water depth is known.

[0005] The present inventor proposed Korean Patent No. 10-1355805 "CONSTRUCTION METHOD FOR UNDERWATER CONCRETE BLOCK STRUCTURE AND UNDERWATER CONCRETE BLOCK STRUCTURE"(-registered on January 15, 2014), and presented a technology for enabling an underwater concrete block structure to have sufficient structural stability even against waves caused by large typhoons, etc., by making an upper concrete block and a lower concrete block structurally integral by concrete columns.

[0006] Meanwhile, soft ground is widely distributed on the seabed, and when an underwater concrete structure is directly installed on the soft ground, the underwater concrete structure subsides, thereby threatening structural stability thereof.

[0007] Therefore, the construction of an underwater concrete structure installed on soft ground is required to be preceded by creating a foundation ground suitable for the installation of the underwater concrete structure through various soft ground improvement methods (a replacement riprap method and a deep mixing treatment method, etc.).

[0008] However, it is difficult to create an appropriate foundation ground in a case in which the depth of the seabed is very deep or a soft ground layer is very thick.

[0009] When the water depth is very deep or the soft ground layer is very thick, it is very difficult for soft ground improvement equipment located on the water surface to pass through the soft ground and reach bedrock, and it is also difficult to accurately inject materials for improving the soft ground.

[0010] For example, in the case of the southern coast of South Korea, the water depth is 30 to 50m, and the thickness of the soft ground is also about 30 to 50m, so in this case, the soft ground improvement equipment is required to be at least 60 to 100m long to reach the bedrock.

Disclosure

Technical Problem

[0011] The present disclosure has been made to solve the problems in the prior art as described above, and is intended to propose an underwater concrete structure and a construction method therefor, in which a soft ground concrete column part, which is a portion of a concrete column, is capable of supporting the lower end of a main concrete structure to prevent the main concrete structure from subsiding in seabed soft ground.

Technical Solution

[0012] In order to accomplish the above objectives, the present invention provides a construction method for an underwater concrete structure for preventing subsidence at seabed soft ground, the construction method including: installing a main concrete structure having a plurality of vertical penetration holes extending vertically on an upper part of seabed soft ground which is on a top of seabed rock; forming a ground perforated part in the seabed soft ground and the seabed rock by perforating the seabed soft ground and the seabed rock located under each of the vertical penetration holes through the vertical penetration hole after the installing of the main concrete structure; and forming a concrete column along the vertical penetration hole and the ground perforated part by inserting a concrete column formation part, which comprises a concrete reinforcing member extending vertically, a waterproof membrane covering lower and side portions of the concrete reinforcing member, and fresh concrete injected into the waterproof membrane, into the vertical penetration hole and the ground perforated part after the forming of the ground perforated part, wherein the concrete column is divided into a penetration hole concrete column part located in the vertical penetration hole, a soft ground concrete column part located in the seabed soft ground, and a rock concrete column part located in the seabed rock, wherein the soft ground concrete column part is formed to support a lower end of the main concrete structure by having a diameter larger than a diameter of the penetration hole concrete column part.

[0013] In the above, a waterproof membrane protective cover with a shape of a tube or a basket may be provided on an outer side of the waterproof membrane, with an upper end of the waterproof membrane protective cover positioned on a vertical middle of the waterproof membrane.

[0014] In the above, the waterproof membrane protective cover may be formed as a mesh and be coupled to the outer side of the waterproof membrane via a skirt member.

[0015] In the above, in the forming of the ground perforated part, a protection pipe extending vertically may be inserted through the vertical penetration hole, and the inserted protection pipe may be positioned across the vertical penetration hole and the ground perforated part; and in the forming of the concrete column, the waterproof membrane may be inserted into the vertical penetration hole and the ground perforated part along an interior of the protection pipe, and the protection pipe may be removed after the waterproof membrane is inserted.

[0016] In another idea of the present disclosure, an underwater concrete structure for preventing subsidence at seabed soft ground includes: a main concrete structure which is installed on an upper part of seabed soft ground which is on a top of seabed rock and is spaced apart upward from the seabed rock and has a plurality of vertical penetration holes extending vertically; and a plurality of concrete columns formed continuously along the vertical penetration holes and the seabed soft ground and the seabed rock located under the vertical penetration holes, wherein each of the concrete columns is divided into a penetration hole concrete column part located in each of the vertical penetration holes, a soft ground concrete column part located in the seabed soft ground, and a rock concrete column part located in the seabed rock, and the soft ground concrete column part supports a lower end of the main concrete structure by having a diameter larger than a diameter of the penetration hole concrete column part to prevent subsidence of the main concrete structure.

[0017] In the above, the concrete column may include a concrete reinforcing member formed vertically and arranged across the vertical penetration hole, the seabed soft ground, and the seabed rock, a waterproof membrane covering lower and side portions of the concrete reinforcing member, concrete poured and cured inside the waterproof membrane, and a waterproof membrane protective cover with a shape of a tube or a basket located on an outer side of the waterproof membrane and having an upper end positioned on a vertical middle of the waterproof membrane to protect the waterproof membrane located in the seabed soft ground.

[0018] In the above, the waterproof membrane protective cover may be formed as a mesh and be coupled to the outer side of the waterproof membrane via a skirt member.

Advantageous Effects

[0019] As described above, according to the present disclosure, the soft ground concrete column part, which is a portion of the concrete column, is capable of supporting the lower end of the main concrete structure to prevent the main concrete structure from subsiding in the seabed soft ground.

[0020] Furthermore, according to the present disclosure, the work of forming the soft ground concrete column part is very simple compared to a conventional soft ground improvement method, so it is possible to reduce an overall construction cost.

Description of Drawings

[0021]

FIG. 1 is a perspective view of a concrete block used in a construction method for an underwater concrete structure for preventing subsidence at seabed soft ground according to a first embodiment of the present disclosure,

FIG. 2 is a plan view of a main concrete structure formed on the top of the seabed by installing the concrete blocks of FIG. 1,

FIG. 3 is a cross-sectional conceptual drawing of FIG. 2,

FIG. 4 is a drawing of a ground perforated part formed after forming the main concrete structure of FIG. 3,

FIGS. 5 to 8 are drawings illustrating the process of forming a concrete column in sequence after forming the ground perforated part of FIG. 4,

FIG. 9 is a front view of a waterproof membrane to which a waterproof membrane protective cover of FIG. 5 is attached,

FIG. 10 is an exploded cross-sectional view of FIG. 9,

FIG. 11 is a perspective view of a concrete block used in a construction method for an underwater concrete structure for preventing subsidence at seabed soft ground according to a second embodiment of the present disclosure,

FIG. 12 is a cross-sectional view of a main concrete structure formed by the concrete blocks of FIG. 11,

FIG. 13 is a cross-sectional view of a ground perforated part and a concrete column formed after the state of FIG. 12, and

FIG. 14 is a cross-sectional view of a cap concrete formed after the state of FIG. 13.

Best Mode

[0022] Hereinafter, embodiments of the present disclosure will be described in detail with reference to the accompanying drawings so that those skilled in the art to which the present disclosure belongs can easily embody the present disclosure. However, the present disclosure may be embodied in various different forms and is not limited to the embodiments described herein. In addition, in the drawings, parts irrelevant to the description of the present disclosure are omitted in order to clearly describe the present disclosure, and similar reference numerals are assigned to similar parts throughout the specification.

[0023] Throughout the specification, when a part "includes" a certain component, it means that other components may be further included without being excluded unless specifically stated to the contrary.

[0024] First, a construction method for an underwater concrete structure for preventing subsidence at seabed soft ground according to a first embodiment of the present disclosure will be described.

[0025] FIG. 1 is a perspective view of a concrete block used in a construction method for an underwater concrete structure for preventing subsidence at seabed soft ground according to a first embodiment of the present disclosure, FIG. 2 is a plan view of a main concrete structure formed on the top of the seabed by installing the concrete blocks of FIG. 1, FIG. 3 is a cross-sectional conceptual drawing of FIG. 2, FIG. 4 is a drawing of a ground perforated part formed after forming the main concrete structure of FIG. 3, FIGS. 5 to 8 are drawings illustrating the process of forming a concrete column in sequence after forming the ground perforated part of FIG. 4, FIG. 9 is a front view of a waterproof membrane to which a waterproof membrane protective cover of FIG. 5 is attached, and FIG. 10 is an exploded cross-sectional view of FIG. 9.

Manufacturing a concrete block

[0026] As in FIG. 1, a concrete block 20 is manufactured.

[0027] The concrete block 20 may be formed to have various shapes, but preferably includes at least two block penetration holes 21 extending vertically formed therein.

[0028] Each of the block penetration holes 21 extends vertically with a first diameter.

[0029] Depending on an embodiment, the concrete block 20 may have a space formed for filling the inside thereof, or a space for other purposes or a shape for other purposes.

Forming a main concrete structure

[0030] FIG. 2 is a plan view of a main concrete structure 100, and FIG. 3 is a cross-sectional view of the main concrete structure 100.

[0031] A plurality of concrete blocks 20 manufactured in the manufacturing of the concrete block is installed on the upper part of seabed soft ground 12 which is on the top of seabed rock 11 as in FIG. 3, and as in FIG. 2, the plurality of concrete blocks 20 is installed horizontally and continuously to form the main concrete structure 100.

[0032] That is, in this embodiment, the main concrete structure 100 has a plurality of concrete blocks 20 arranged horizontally and continuously.

[0033] According to an embodiment, the main concrete structure 100 may be composed of one concrete block 20.

[0034] As illustrated in FIG. 3, the main concrete structure 100 is installed spaced apart upward from the seabed rock 11.

[0035] The block penetration holes 21 of the concrete blocks 20 constituting the main concrete structure 100 form vertical penetration holes 101 extending vertically with lower end parts thereof blocked by the seabed soft ground 12 and upper end parts thereof open.

[0036] That is, in this embodiment, the concrete blocks are manufactured in large sizes and installed in only one level vertically, and each of the block penetration holes 21 of each of the concrete blocks 20 functions as each of the vertical penetration holes 101 of the main concrete structure 100.

[0037] Accordingly, the vertical penetration hole 101 is in the form of extending vertically with the first diameter.

Forming a ground perforated part

[0038] After the forming of the main concrete structure, as illustrated in FIG. 4, the seabed soft ground 12 and the seabed rock 11 located under the vertical penetration hole 101 are perforated through the vertical penetration hole 101 and thus a ground perforated part 102, which is a space continuous to the vertical penetration hole 101, is formed in the seabed soft ground 12 and the seabed rock 11.

[0039] In this embodiment, when the ground perforated part 102 is formed by perforating the seabed soft ground 12 and the seabed rock 11 located under the vertical penetration hole 101, a protection pipe 30 extending vertically is vertically inserted into the seabed soft ground 12 and the seabed rock 11 through the vertical penetration hole 101.

[0040] The protection pipe 30 inserted in this manner is positioned across the vertical penetration hole 101 and the ground perforated part 102, and the ground perforated part 102 is formed inside the protection pipe 30.

[0041] In this case, the protection pipe 30 prevents the surrounding seabed soft ground 12 from collapsing into the ground perforated part 102 or prevents various types of foreign substances from being introduced into the ground perforated part 102 during or after the perforating operation.

[0042] In addition, the protection pipe 30 serves to protect the waterproof membrane 112 when a waterproof membrane 112 to be described later is inserted into the protection pipe 30.

Forming a concrete column

[0043] After the forming of the ground perforated part, a concrete column 110 is formed along the vertical penetration hole 101 and the ground perforated part 102.

[0044] The forming of the concrete column in this embodiment is performed step by step as illustrated in FIGS. 5 to 8.

[0045] A concrete column formation part, which includes a concrete reinforcing member 111 extending vertically, the waterproof membrane 112 covering lower and side portions of the concrete reinforcing member 111, fresh concrete 113 injected into the waterproof membrane 112, and a waterproof membrane protective cover 114 coupled to the outer side of the waterproof membrane 112, is inserted into the vertical penetration hole 101 and the ground perforated part 102 so as to form the concrete column 110 along the vertical penetration hole 101 and the ground perforated part 102.

[0046] First, as illustrated in FIGS. 5 and 6, the concrete reinforcing member 111, such as a reinforcing bar assembly extending vertically, is inserted into the vertical penetration hole 101 and the ground perforated part 102.

[0047] In this embodiment, since the protection pipe 30 is already positioned in the vertical penetration hole 101 and the ground perforated part 102, the concrete reinforcing member 111 is inserted into the protection pipe 30.

[0048] In this case, while the lower and side portions of the concrete reinforcing member 111 is covered by the waterproof membrane 112, the concrete reinforcing member 111 is inserted into the vertical penetration hole 101 and the ground perforated part 102.

[0049] Meanwhile, the waterproof membrane protective cover 114 is provided on the outer side of the waterproof membrane 112 via a skirt member 115.

[0050] The waterproof membrane protective cover 114 is in the form of a tube or basket (the form of a basket in the present embodiment) with an upper end thereof positioned on the vertical middle of the waterproof membrane 112, and a lower end portion of the waterproof membrane 112 (specifically, a portion to be positioned in the seabed soft ground) is positioned inside the waterproof membrane protective cover 114.

[0051] The waterproof membrane protective cover 114 may be a mesh which is woven from wire or carbon fiber and formed into the shape of a tube or a basket.

[0052] Here, the tube shape is a cylindrical shape with the top and bottom open, and the basket shape is a cylindrical shape with the top open and the bottom closed.

[0053] The skirt member 115 is provided between the waterproof membrane protective cover 114 and the waterproof membrane 112.

[0054] The upper end of the skirt member 115 is joined to the vertical middle of the outer side of the waterproof membrane 112, and the upper end of the waterproof membrane protective cover 114 is coupled to the lower end of the skirt member 115 by means of stitching or the like.

[0055] Accordingly, after the concrete reinforcing member 111 covered by the waterproof membrane 112 is inserted into the protection pipe 30, the concrete 113 is poured inside the waterproof membrane 112 to form the concrete column 110 as illustrated in FIGS. 7 and 8.

[0056] FIG. 7 is a drawing showing a state in which the protection pipe 30 is slightly raised while some of the fresh concrete 113 is poured inside the waterproof membrane 112.

[0057] That is, in FIG. 7, the protection pipe 30 is raised so that the lower end of the protection pipe 30 is just outside the ground perforated part 102, and the fresh concrete 113 required for the ground perforated part 102 is poured inside the waterproof membrane 112.

[0058] In this case, the waterproof membrane 112 located in the seabed soft ground 12 has a diameter increased by the pressure of the fresh concrete 113.

[0059] In FIG. 7, extent to which the diameter of the waterproof membrane 112 located in the seabed soft ground 12 increases is greatly exaggerated, and in reality, as the fresh concrete 113 is gradually injected into the waterproof membrane 112, the pressure of the fresh concrete 113 located in the seabed soft ground 12 gradually increases. As the pressure gradually increases, the diameter of the waterproof membrane 112 located in the seabed soft ground 12 gradually increases, and this increase of the diameter of the waterproof membrane 112 continues until the fresh concrete 113 is fully injected into the waterproof membrane 112, as illustrated in FIG. 8.

[0060] The waterproof membrane 112 is required to have a structure that allows for the diameter increase structurally (e.g., a structure that unfolds from a folded state) or through a material (e.g., a stretchable elastic material) in consideration of the increase of a diameter.

[0061] In addition, the waterproof membrane protective cover 114 prevents the waterproof membrane 112 from being damaged due to excessive diameter increase by allowing the waterproof membrane 112 to expand in diameter only within a certain limit.

[0062] In addition, the waterproof membrane protective cover 114 is made as mesh and prevents air or water from remaining between the waterproof membrane protective cover 114 and the waterproof membrane 112.

[0063] In this manner, the protection pipe 30 is gradually raised while the fresh concrete 113 is gradually poured inside the waterproof membrane 112, and finally, as illustrated in FIG. 8, the protection pipe 30 is completely removed, and the pouring of the fresh concrete 113 throughout the vertical penetration hole 101 and the ground perforated part 102 is completed.

[0064] That is, the protection pipe 30 is removed before the fresh concrete 113 that has been poured is hardened.

[0065] When the fresh concrete 113 is poured into the waterproof membrane 112 in this way, the waterproof membrane 112 is brought into close contact with the seabed rock 11 and the concrete block 20 (or the main concrete structure 100) by the pressure of the fresh concrete 113, and has a diameter increased significantly in the seabed soft ground 12 increases, and then goes through a curing process to be the concrete column 110.

[0066] In this way, the concrete column 110 is formed in the main concrete structure 100, thereby completing an underwater concrete structure 200.

[0067] That is, the concrete column 110 includes a penetration hole concrete column part 110a located in the vertical penetration hole 101 and extending vertically with the first diameter, a soft ground concrete column part 110b located in the seabed soft ground 12 and extending vertically with a second diameter, and a rock concrete column part 110c located in the seabed rock 11 and extending vertically with a third diameter.

[0068] In addition, since the soft ground concrete column part 110b has a diameter larger than the diameter of the penetration hole concrete column part 110a, the soft ground concrete column part 110b supports the lower end of the main concrete structure 100, thereby preventing the main concrete structure 100 from subsiding.

[0069] That is, according to the present disclosure, the main concrete structure 100 may be prevented from subsiding without performing separate soft ground improvement work on the seabed soft ground 12.

[0070] Hereinafter, a second embodiment of the present disclosure will be described.

[0071] FIG. 11 is a perspective view of a concrete block used in a construction method for an underwater concrete structure for preventing subsidence at seabed soft ground according to a second embodiment of the present disclosure, FIG. 12 is a cross-sectional view of a main concrete structure formed by the concrete blocks of FIG. 11, FIG. 13 is a cross-sectional view of a ground perforated part and a concrete column formed after the state of FIG. 12, and FIG. 14 is a cross-sectional view of a cap concrete formed after the state of FIG. 13.

[0072] Below, only differences from the first embodiment are mainly explained, and the descriptions of parts that are the same as the first embodiment are omitted.

Manufacturing a concrete block

[0073] In this embodiment, the concrete block 20 as illustrated in FIG. 11 is manufactured.

[0074] The concrete block 20 of the present embodiment has a plurality of block penetration holes 21 formed therein, and each of the block penetration holes 21 has the shape of a corrugated pipe extending vertically as illustrated in FIG. 12.

Forming a main concrete structure

[0075] The concrete blocks 20 are stacked vertically to form the main concrete structure 100 as illustrated in FIG. 12. The concrete blocks 20 are stacked in 7 layers.

[0076] Compared to the first embodiment, in the second embodiment, water depth is greater, and the layer of the seabed soft ground 12 is thicker.

[0077] In this case, since the block penetration hole 21 of the concrete block 20 has the shape of a corrugated pipe that extends vertically, the vertical penetration hole 101 of the main concrete structure 100 also has the shape of a corrugated pipe that extends vertically.

[0078] The vertical penetration hole 101 in the form of a corrugated pipe enhances bonding strength with the concrete column 110.

[0079] As described above, the main concrete structure 100 may be formed by stacking a plurality of concrete blocks 20 vertically.

Forming a ground perforated part and forming a concrete column

[0080] After the state of FIG. 12, the ground perforated part is formed through the vertical penetration hole 101 of the main concrete structure 100, and the concrete column 110 is formed along the vertical penetration hole 101 and the ground perforated part to obtain a state as in FIG. 13.

[0081] This step is substantially the same as the first embodiment, so a detailed description thereof is omitted.

Forming cap concrete

[0082] After the state of FIG. 13, a cap concrete 120 is formed on the top of the main concrete structure 100.

[0083] The reinforcing bar assembly of the cap concrete 120 is connected to the concrete reinforcing member 111 of the concrete column 110.

[0084] The foregoing description of the present disclosure is for illustrative purposes only, and those skilled in the art to which the present disclosure pertains will understand that the present disclosure may be easily modified into another specific form without changing its technical idea or essential features. Therefore, the embodiments described above should be understood in all respects as illustrative and not restrictive. For example, any component described as a single component may be implemented in a divided form, and similarly, components described as separate may be implemented in a combined form.

[0085] The scope of the present disclosure is indicated by the claims described below rather than the detailed description above, and the meaning and scope of the patent claims and all changes or modified forms derived from the equivalent concept thereof should be construed as being included in the scope of the present disclosure.

Industrial Applicability

[0086] The present disclosure may be used as an underwater concrete structure installed underwater for various purposes, such as berthing facilities for ports, coastal wave-dissipating structures, and breakwaters.

Claims

1. A construction method for an underwater concrete structure for preventing subsidence at seabed soft ground, the construction method comprising:

    installing a main concrete structure having a plurality of vertical penetration holes extending vertically on an upper part of seabed soft ground which is on a top of seabed rock;
    forming a ground perforated part in the seabed soft ground and the seabed rock by perforating the seabed soft ground and the seabed rock located under each of the vertical penetration holes through the vertical penetration hole after the installing of the main concrete structure; and
    forming a concrete column along the vertical penetration hole and the ground perforated part by inserting a concrete column formation part, which comprises a concrete reinforcing member extending vertically, a waterproof membrane covering lower and side portions of the concrete reinforcing member, and fresh concrete injected into the waterproof membrane, into the vertical penetration hole and the ground perforated part after the forming of the ground perforated part, wherein the concrete column is divided into a penetration hole concrete column part located in the vertical penetration hole, a soft ground concrete column part located in the seabed soft ground, and a rock concrete column part located in the seabed rock, wherein the soft ground concrete column part is formed to support a lower end of the main concrete structure by having a diameter larger than a diameter of the penetration hole concrete column part.

2. The construction method of claim 1, wherein a waterproof membrane protective cover with a shape of a tube or a basket is provided on an outer side of the waterproof membrane, with an upper end of the waterproof membrane protective cover positioned on a vertical middle of the waterproof membrane.

3. The construction method of claim 2, wherein the waterproof membrane protective cover is formed as a mesh and is coupled to the outer side of the waterproof membrane via a skirt member.

4. The construction method of claim 1, wherein in the forming of the ground perforated part, a protection pipe extending vertically is inserted through the vertical penetration hole, and the inserted protection pipe is positioned across the vertical penetration hole and the ground perforated part; and
    in the forming of the concrete column, the waterproof membrane is inserted into the vertical penetration hole and the ground perforated part along an interior of the protection pipe, and the protection pipe is removed after the waterproof membrane is inserted.

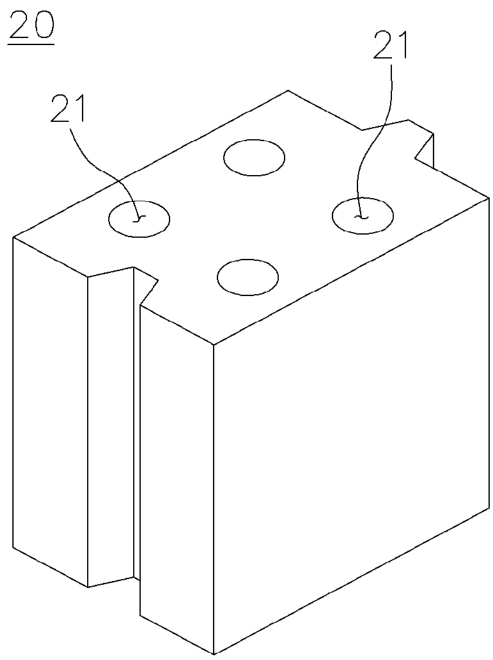
5. An underwater concrete structure for preventing subsidence at seabed soft ground, the underwater concrete structure comprising:

    a main concrete structure installed on an upper part of seabed soft ground on a top of seabed rock, wherein the main concrete structure is spaced apart upward from the seabed rock and has a plurality of vertical penetration holes extending vertically; and
    a plurality of concrete columns formed continuously along the vertical penetration holes and the seabed soft ground and the seabed rock located under the vertical penetration holes,
    wherein each of the concrete columns is divided into a penetration hole concrete column part located in each of the vertical penetration holes, a soft ground concrete column part located in the seabed soft ground, and a rock concrete column part located in the seabed rock, and
    the soft ground concrete column part supports a lower end of the main concrete structure by having a diameter larger than a diameter of the penetration hole concrete column part to prevent subsidence of the main concrete structure.

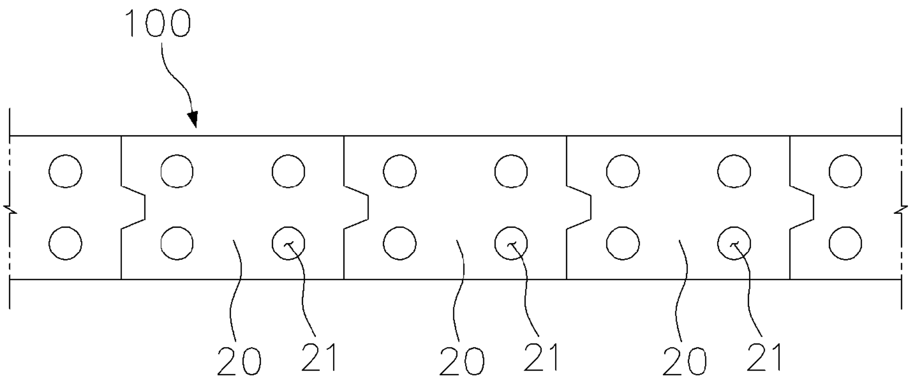
6. The underwater concrete structure of claim 5, wherein the concrete column comprises a concrete reinforcing member formed vertically and arranged across the vertical penetration hole, the seabed soft ground and the seabed rock, a waterproof membrane covering lower and side portions of the concrete reinforcing member, concrete poured and cured inside the waterproof membrane, and a waterproof membrane protective cover with a shape of a tube or a basket located on an outer side of the waterproof membrane and having an upper end positioned on a vertical middle of the waterproof membrane to protect the waterproof membrane located in the seabed soft ground.

7. The underwater concrete structure of claim 6, wherein the waterproof membrane protective cover is formed as a mesh and is coupled to the outer side of the waterproof membrane via a skirt member.

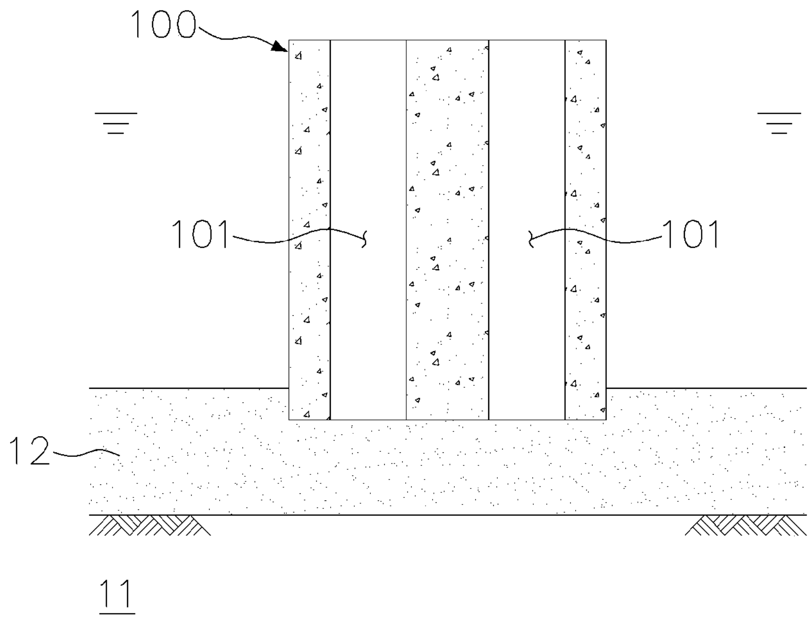
【Fig.1】



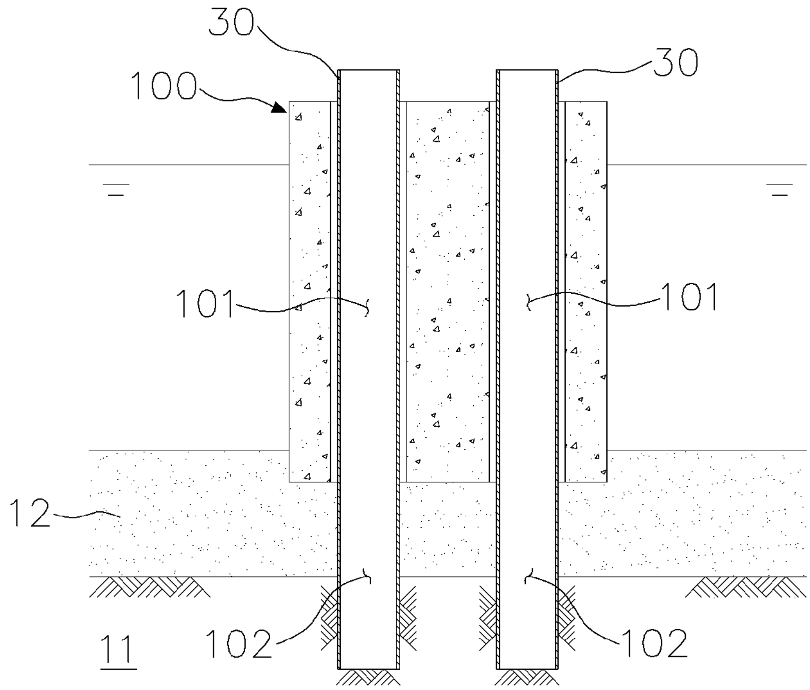
【Fig.2】



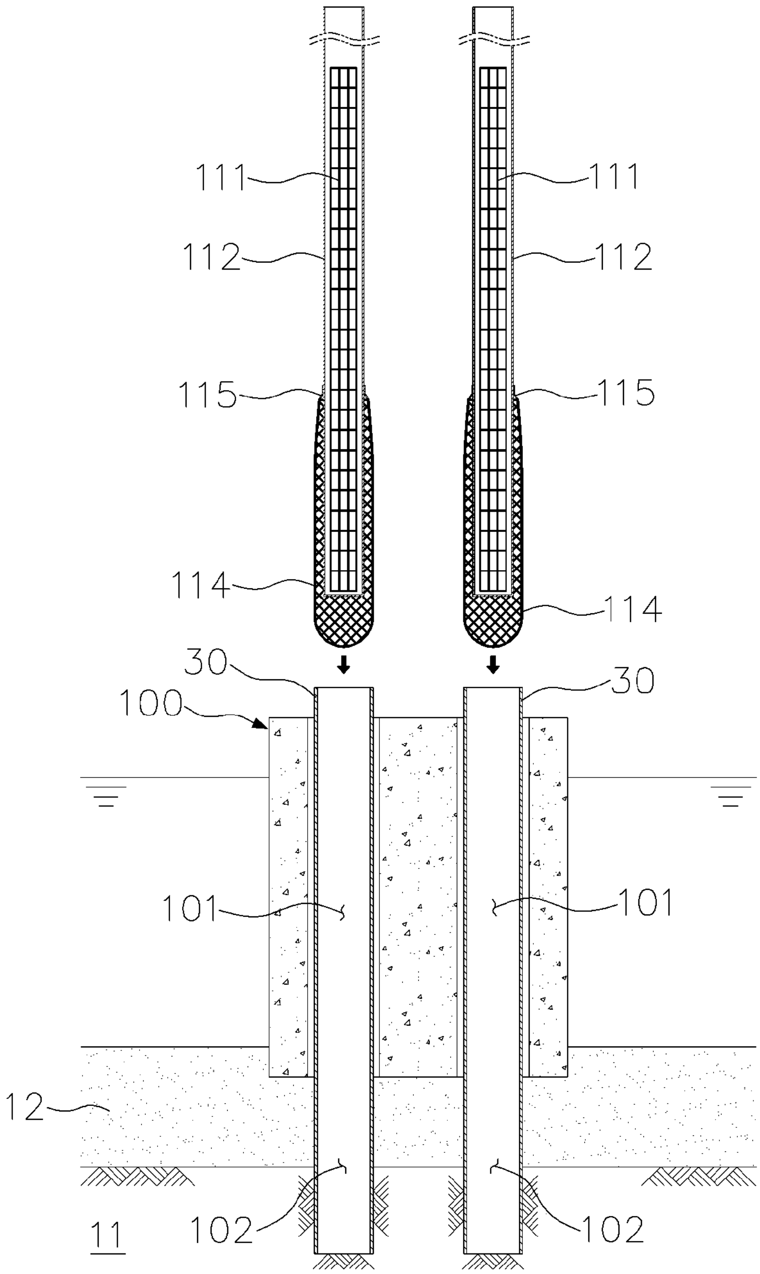
【Fig.3】



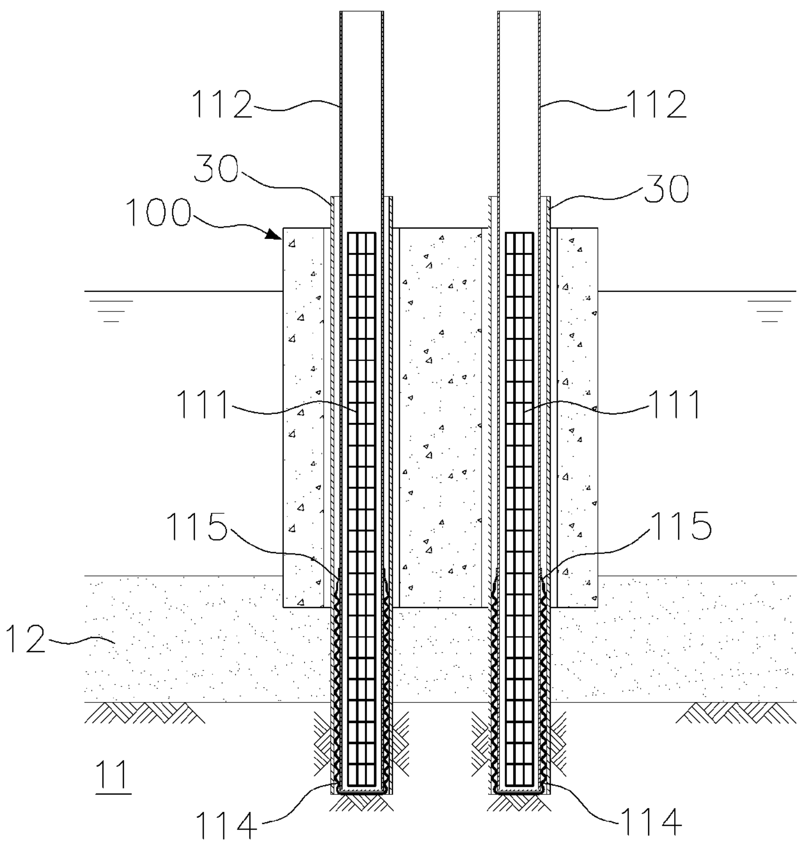
【Fig.4】



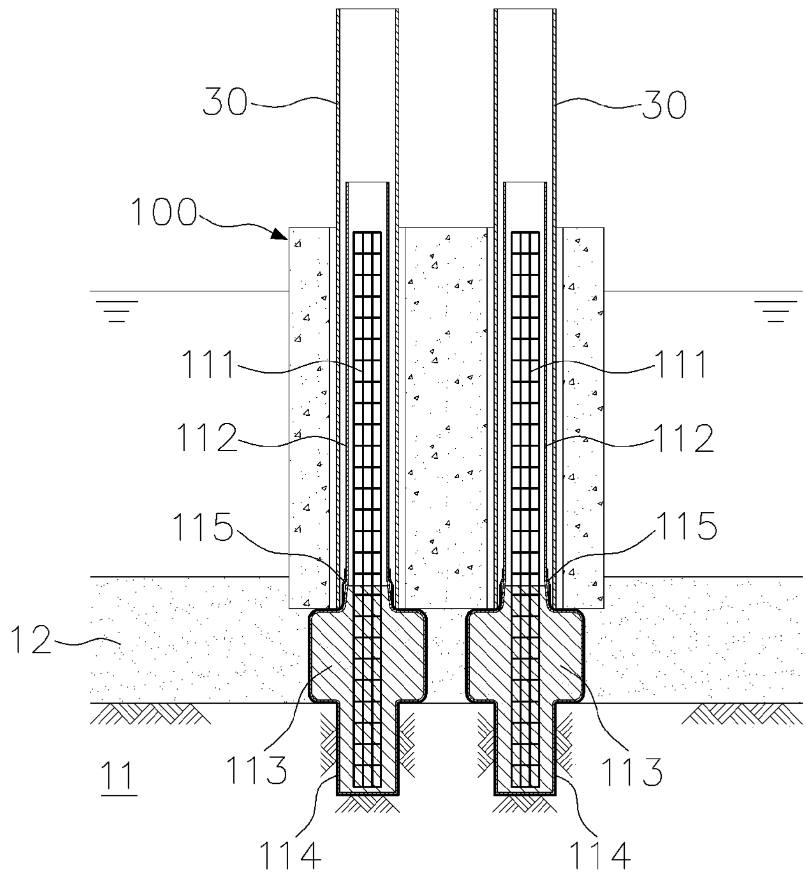
【Fig.5】



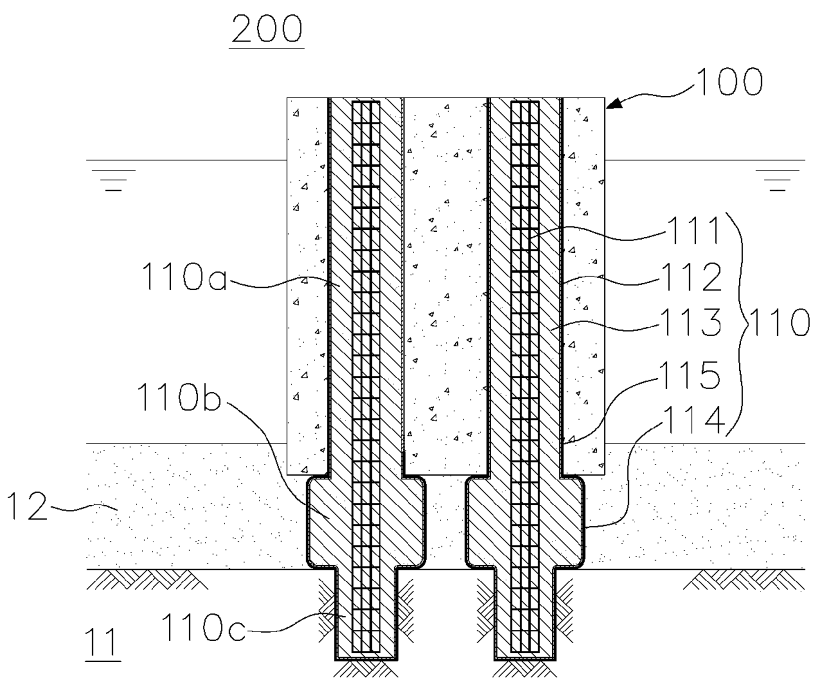
【Fig.6】



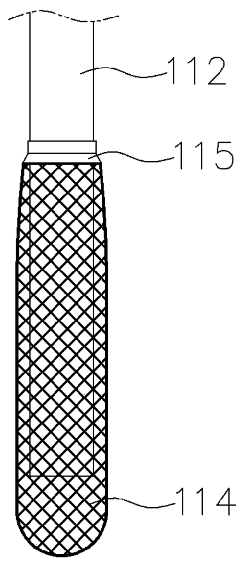
【Fig.7】



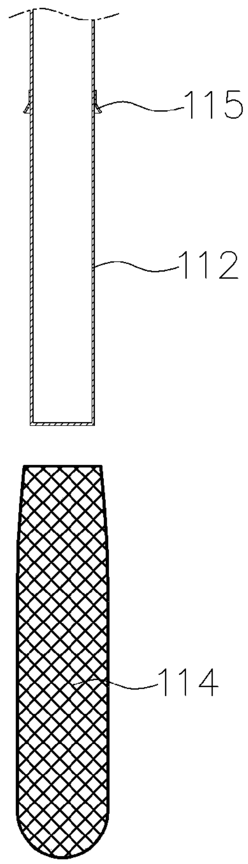
【Fig.8】



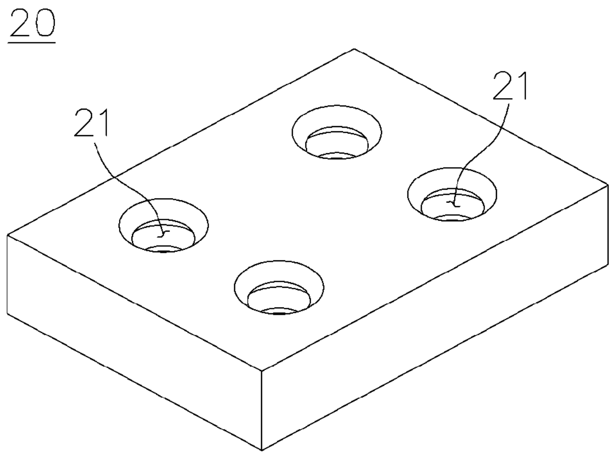
【Fig.9】



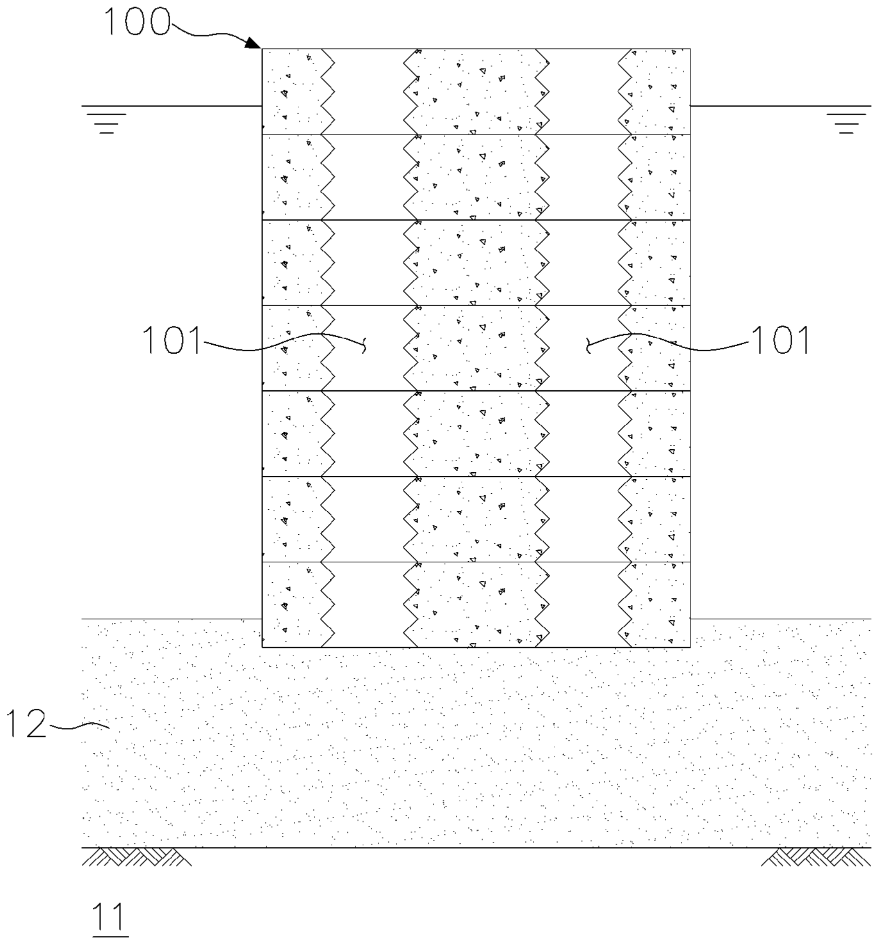
【Fig.10】



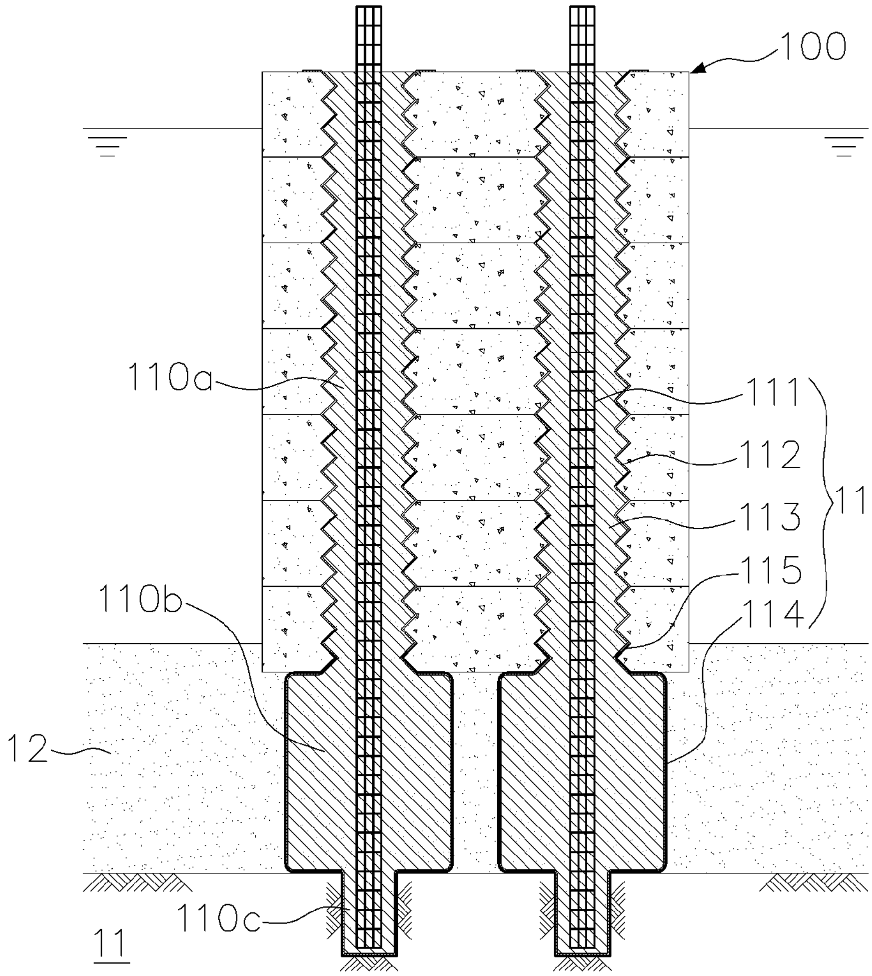
【Fig.11】



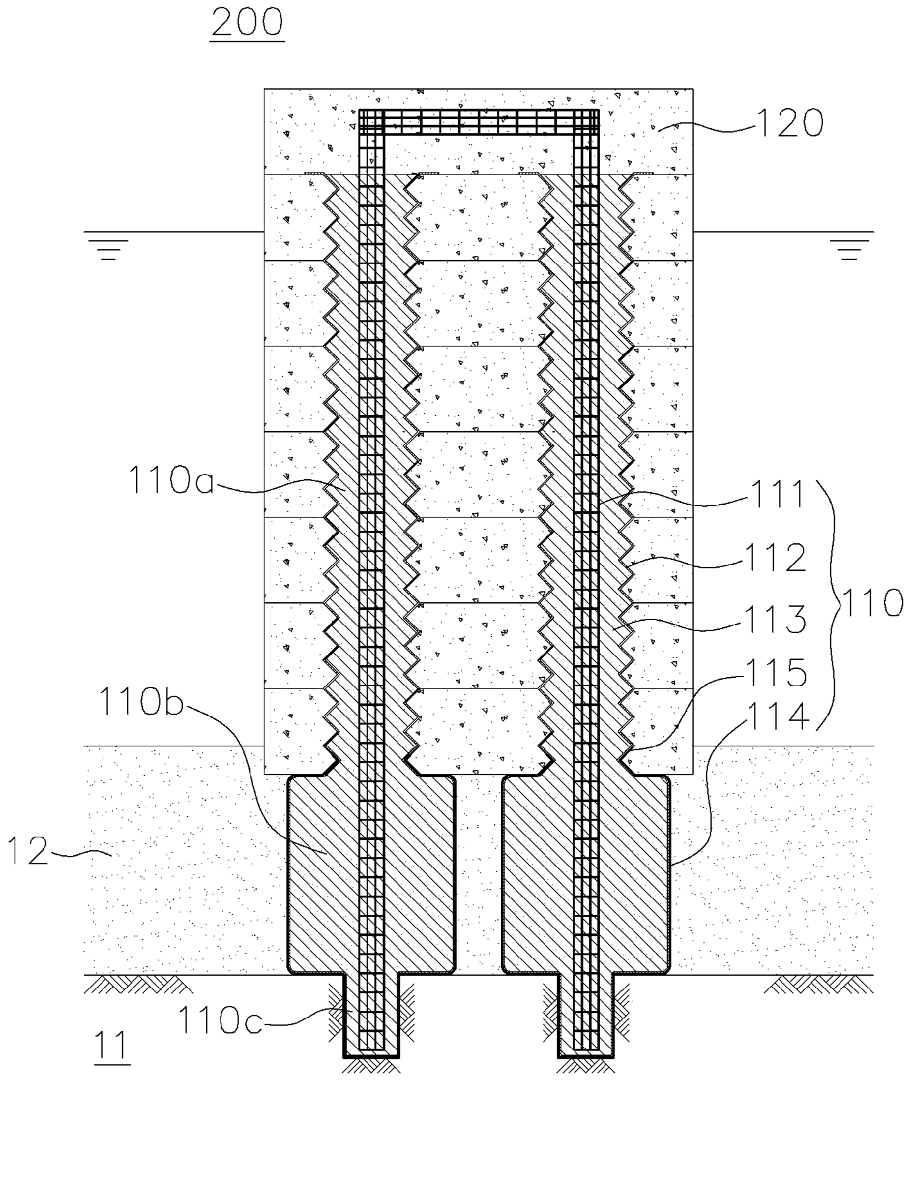
【Fig.12】



【Fig.13】



【Fig.14】



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2023/008492

A. CLASSIFICATION OF SUBJECT MATTER

E02D 31/00(2006.01)i; **E02D 37/00**(2006.01)i; **E02D 27/42**(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E02D 31/00(2006.01); E02B 3/06(2006.01); E02D 15/00(2006.01); E02D 25/00(2006.01); E02D 27/00(2006.01); E02D 27/42(2006.01); E02D 3/10(2006.01); E02D 5/34(2006.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models: IPC as above
Japanese utility models and applications for utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS (KIPO internal) & keywords: 수중(underwater), 건설(construction), 콘크리트(concrete), 천공(drilling), 및 연약 지반(poor ground)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 10-2022341 B1 (KIM, Sang Gi) 18 September 2019 (2019-09-18) See paragraphs [0035]-[0079] and figures 1-8 and 17.	1-7
A	KR 10-1992-0002713 B1 (KUMTO DEVELOPMENT CO.) 31 March 1992 (1992-03-31) See paragraphs [0012]-[0038] and figure 1.	1-7
A	KR 10-0576644 B1 (LIM, Chol Woong) 08 May 2006 (2006-05-08) See paragraphs [0012]-[0024] and figures 1-12.	1-7
A	KR 10-2021-0029069 A (KIM, Sang Gi) 15 March 2021 (2021-03-15) See paragraphs [0038]-[0090] and figures 1-8.	1-7
A	US 2006-0185279 A1 (EUSTERBARKEY, Carsten) 24 August 2006 (2006-08-24) See paragraphs [0052]-[0070] and figures 1-5.	1-7

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
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"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 September 2023	**20 September 2023**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office **Government Complex-Daejeon Building 4, 189 Cheongsa-ro, Seo-gu, Daejeon 35208**	
Facsimile No. **+82-42-481-8578**	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2023/008492

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	KR 10-2477117 B1 (YUJOO CO., LTD.) 13 December 2022 (2022-12-13) See paragraphs [0025]-[0092]; claims 1-7; and figures 1-14. ※ This document is the published patent of an earlier application that serves as a basis for claiming priority of the present international application.	1-7

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2023/008492

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
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		CA 3127315 A1	03 September 2020
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		CN 113330164 A	31 August 2021
		EP 3933114 A1	05 January 2022
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KR 10-1992-0002713 B1	31 March 1992	KR 10-1989-0002499 A	10 April 1989
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US 2006-0185279 A1	24 August 2006	DE 10330963 A1	27 January 2005
		GB 2418696 B	04 April 2007
		WO 2005-005752 A1	20 January 2005
KR 10-2477117 B1	13 December 2022	None	

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- KR 101355805 **[0005]**