

METHOD FOR CONSTRUCTING CAISSON ON THE SEA USING BUOYANCY AND CAISSON ASSEMBLY THEREFOR

CROSS-REFERENCE TO RELATED PATENT APPLICATIONS

This application claims the benefit of Korean Patent Application No. 10-2020-0001470, filed on January 06, 2020, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein in its entirety by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a technology for constructing a marine structure, and more particularly, to a technology for constructing a caisson on the sea.

2. Description of the Related Art

A caisson is a reinforced concrete structure generally weighing several thousand tons, is installed on the sea and used for the construction of berthing facilities such as quay walls. According to the related art, caissons have a large number of wall structures along a thickness direction, are launched by using buoyancy from the sea to a construction site, are moved, and then sunken by supplying water therein. Structurally, a caisson having no rear wall and no bulkhead compared to the existing caisson may be used. In this case, since the amount of materials is greatly reduced compared to the existing caisson, there is an advantage such as a reduction in construction cost. However, in the caisson in which the rear wall and the bulkhead are removed, it is difficult to provide sufficient buoyancy, and it is difficult to maintain a stable center of buoyancy. Thus, self-launching is not possible.

[Prior-art document]

[Patent document]

Korean Patent Registration No. 10-0982970 entitled "Breakwater construction method using waved shape caisson" (registered on September 13, 2010)

SUMMARY OF THE INVENTION

The present invention provides a method for constructing a caisson on the sea, the caisson having a wall structure of a smaller volume compared to the existing caisson, and a caisson assembly therefor.

The present invention provides a method for constructing a caisson on the sea, whereby construction cost can be reduced compared to the existing caisson constructing method, and a caisson assembly therefor.

According to an aspect of the present invention, there is provided a method for constructing a caisson on the sea using buoyancy, the method including preparing a caisson to be constructed, preparing a buoyancy tank, the buoyancy tank being coupled to the caisson to be constructed and providing buoyancy, coupling the caisson to be constructed to the buoyancy tank on the sea so as to form a caisson assembly, and transporting the caisson assembly to a construction site of the caisson to be constructed on the sea, wherein the caisson to be constructed includes a base portion and a wall portion, the wall portion extending upward from the base portion, positioned adjacent to a front end from among the front end and a rear end of the base portion and providing an inner space, and in the coupling, the buoyancy tank is detachably coupled to the wall portion by a coupling unit.

According to another aspect of the present invention, there is provided a caisson assembly for constructing a caisson on the sea using buoyancy, the caisson assembly including an L-shaped caisson including a base portion and a wall portion, the wall portion extending upward from the base portion, positioned adjacent to a front end from among the front end and a rear end of the base portion and providing an inner space, a buoyancy tank coupled to the L-shaped

caisson and providing buoyancy, and a coupling unit detachably coupling the L-shaped caisson and the buoyancy tank.

BRIEF DESCRIPTION OF THE DRAWINGS

5 The above and other features and advantages of the present invention will become more apparent by describing in detail exemplary embodiments thereof with reference to the attached drawings in which:

10 FIG. 1 is a flowchart schematically illustrating a method for constructing a caisson on the sea using buoyancy according to an embodiment of the present invention;

 FIG. 2 is a perspective view illustrating a caisson prepared in an operation of preparing the caisson shown in FIG. 1;

 FIG. 3 is a perspective view illustrating a buoyancy tank prepared in an operation of preparing the buoyancy tank shown in FIG. 1;

15 FIGS. 4 and 5 are views illustrating a state in which a coupling operation shown in FIG. 1 is performed;

 FIG. 6 is a perspective view illustrating a caisson assembly formed by coupling the caisson and the buoyancy tank by performing the coupling operation shown in FIG. 1;

20 FIG. 7 is an enlarged cross-sectional view illustrating a fastening unit for coupling the caisson and the buoyancy tank in the caisson assembly shown in FIG. 6;

25 FIG. 8 is a view illustrating a state in which the caisson assembly is transported and located at a construction site by performing an operation of transporting the caisson assembly shown in FIG. 1;

 FIG. 9 is a view illustrating a state in which the caisson assembly is seated on the construction site by performing an operation of sinking the assembly shown in FIG. 1; and

30 FIG. 10 is a view illustrating a state in which the buoyancy tank is separated from the caisson by performing a dismantling operation shown in FIG. 1.

DETAILED DESCRIPTION OF THE INVENTION

Hereinafter, the configuration and operation of embodiments of the present invention will be described in detail with reference to the attached drawings.

5 FIG. 1 is a flowchart schematically illustrating a method for constructing a caisson on the sea using buoyancy according to an embodiment of the present invention. Referring to FIG. 1, the method for constructing a caisson on the sea using buoyancy according to an embodiment of the present invention includes an operation of preparing a caisson (S11) in which a caisson to be constructed is prepared, an operation of preparing a buoyancy tank (S12) in which the buoyancy tank to be coupled to the caisson to be constructed is prepared, a coupling operation (S20) in which the caisson to be constructed and the buoyancy tank are coupled to each other so as to form a caisson assembly, an operation of transporting an assembly (S30) in which the caisson assembly formed through the coupling operation (S20) is transported to a construction site on the sea, an operation of sinking the assembly (S40) in which the caisson assembly transported to the construction site on the sea through the operation of transporting the assembly (S30) is sunken, and a dismantling operation (S50) in which the buoyancy tank is separated from the caisson assembly sunken at the construction site through the operation of sinking the assembly (S40).

15 In the operation of preparing the caisson (S11), a caisson to be constructed, which is a reinforced concrete structure, is manufactured and prepared. FIG. 2 is a view illustrating an example of the caisson to be constructed prepared through the operation of preparing the caisson (S11). Referring to FIG. 2, a caisson 110 to be constructed includes a plate-shaped base portion 111, a wall portion 120 formed by extending upward from the base portion 111, and a buoyancy tank seating portion 130 formed on the base portion 111, and a plurality of support wing walls 140 formed by extending upward from the base portion 111.

The base portion 111 is a flat plate-like shape arranged horizontally, and the wall portion 120, the buoyancy tank seating portion 130, and the plurality of support wing walls 140 are arranged on a top surface of the base portion 111.

The wall portion 120 is formed by extending vertically upward from the base portion 111. The wall portion 120 is positioned adjacent to a front end 112 from among the front end 112 and a rear end 113 of the base portion 111 in the base portion 111. Accordingly, the side shape of the wall portion 120 has a substantially "L" shape. The wall portion 120 includes a front wall 121, a rear wall 123 spaced apart from the front wall 121, two side walls 125 respectively connecting both side ends of the front wall 121 and both side ends of the rear wall 123, and a plurality of rib walls 127 connecting the front wall 121 and the rear wall 123. An inner space 120a formed by the front wall 121, the rear wall 124 and the two side walls 125 is formed inside the wall portion 120. The inner space 120a communicates with the outside through an open upper end of the wall portion 120. The wall portion 120 has a wall shape that is formed so that both sides of the wall portion 120 entirely face the front end 112 and the rear end 113 of the base portion 111.

The front wall 121 is a straight wall formed by extending substantially vertically from the base portion 111 and is located closer to the front end 112 of the base portion 111 than the rear wall 123. Two side walls 125 are respectively connected to both side ends of the front wall 121.

The rear wall 123 is a straight wall formed by extending substantially vertically from the base portion 111 and facing the front wall 121 and is located farther away from the front end 112 than the front wall 121. A plurality of coupling holes 124 are formed in the rear wall 123 and are positioned adjacent to an upper end 123a. Each of the plurality of coupling holes 124 is a hole passing through the rear wall 123. The two side walls 125 are connected to both side ends of the rear wall 123, respectively. The buoyancy tank seating portion 130 is positioned adjacent to the rear wall 123.

Each of the two side walls 125 connects both side ends of the front wall 121 and both side ends of the rear wall 123, respectively. A distance between

the two side walls 125 is formed much greater than a distance between the front wall 121 and the rear wall 123.

The plurality of rib walls 127 are arranged in the inner space 120a of the wall portion 120 and are sequentially spaced apart from one another at equal intervals along a width direction W of the wall portion 120. Each of the plurality of rib walls 127 connects the front wall 121 and the rear wall 123 and improves the structural strength of the wall portion 120.

The buoyancy tank seating portion 130 is formed in contact with the wall portion 120 on the base portion 111. The buoyancy tank seating portion 130 has an end wall 131 spaced apart from the rear wall 123 of the wall portion 120, and both side end walls 133 connecting both side ends of the rear wall 123 of the wall portion 120 and both side ends of the end wall 131, and a plurality of partition walls 135 that partition the inner space 130a of the buoyancy tank seating portion 130. The end wall 131 and two side end walls 133 form a circumferential wall 132 forming the inner space 130a of the buoyancy tank seating portion 130. The inner space 130a of the buoyancy tank seating portion 130 is a buoyancy tank seating space, and a lower portion of the buoyancy tank is inserted into the inner space 130a and seated thereon.

The end wall 131 is spaced apart from the rear wall 123 of the wall portion 120 and is formed substantially parallel to the rear wall 123. The end wall 131 is formed lower than the rear wall 123. Side end walls 133 are respectively connected to both side ends of the end wall 131.

Each of the two side end walls 133 connects both side ends of the end wall 131 and the wall portion 120. Each of the two side end walls 133 is formed to have the same height as the end wall 131.

The plurality of partition walls 135 are arranged in the inner space 130a of the buoyancy tank seating portion 130 and are sequentially spaced apart from one another substantially at equal intervals along a width direction W of the wall portion 120. Each of the plurality of partition walls 135 connects the end wall 131 and the rear wall 123 of the wall portion 120. In the present embodiment, each of the plurality of partition walls 135 will be described as being formed at the same height as the end wall 131 and the two side end

walls 133. The inner space 130a of the buoyancy tank seating portion 130 is partitioned into a plurality of seating grooves 136 by the plurality of partition walls 135.

Each of the plurality of support wing walls 140 is formed to be erected upward from the base portion 111. The plurality of support wing walls 140 are arranged between the buoyancy tank seating portion 130 and the rear end 113 of the base portion 111 and are sequentially spaced apart from one another substantially at equal intervals along the width direction W of the wall portion 120. Each of the plurality of support wing walls 140 is preferably positioned to correspond to each of the plurality of partition walls 135 formed in the buoyancy tank seating portion 130, as shown. Each of the plurality of support wing walls 140 has a shape extending from the end wall 131 of the buoyancy tank seating portion 130 toward the rear end 113 of the base portion 111 and has a triangular shape in which the height of the support wing wall 140 decreases toward the rear end 113 of the base portion 111.

In the operation of preparing the buoyancy tank (S12), a buoyancy tank to be coupled to the caisson 110 to be constructed prepared through the operation of preparing the caisson (S11) is prepared. FIG. 2 shows an example of the buoyancy tank prepared through the operation of preparing the buoyancy tank (S12). Referring to FIG. 2, a buoyancy tank 150 is a hollow structure that provides an inner space 150a and has an open upper portion, and includes a flat first wall portion 151, a flat second wall portion 155 facing the first wall portion 151, two side wall portions 159 respectively connecting both side ends of the first wall portion 151 and both side ends of the second wall portion 155, and a plurality of partition walls 154 formed in the inner space 150a.

The first wall portion 151 has a flat wall shape and has a shape and size corresponding to the rear wall 123 of the wall portion 120 provided in the caisson 110 shown in FIG. 1. A plurality of through holes 153 are formed in the first wall portion 151 and are positioned adjacent to an upper end 152. The plurality of through holes 153 are sequentially arranged along a width direction of the buoyancy tank 150. Each of the plurality of through holes 153

corresponds to the plurality of coupling holes 124 formed in the rear wall 123 of the wall portion 120 provided in the caisson 110.

The second wall portion 155 has a flat wall shape and is arranged to face the first wall portion 151 while being spaced apart from each other by a predetermined distance. The second wall portion 155 is connected to the first wall portion 151 by the two side wall portions 159.

Each of the two side wall portions 159 connects both side ends of the first wall portion 151 to both side ends of the second wall portion 155 and provides the inner space 150a with only an upper portion open inside the buoyancy tank 150.

The plurality of partition walls 154 are arranged in the inner space 150a to partition the inner space 150a into a plurality of unit spaces and structurally reinforce the buoyancy tank 150. It will be described that the plurality of partition walls 154 are sequentially arranged along the width direction of the buoyancy tank 150 and each of the plurality of partition walls 154 is connected to the first wall portion 151 and the second wall portion 155, respectively. However, the present invention is not limited thereto, and the plurality of partition walls 154 may be formed in a different shape and may support the buoyancy tank 150 structurally.

In addition, a plurality of protrusions 160 are formed in a lower portion of the buoyancy tank 150 and are sequentially spaced apart from one another along the width direction of the buoyancy tank 150. Each of the plurality of protrusions 160 has a protruding shape, and has a size and shape corresponding to each of the plurality of seating grooves 136 formed in the buoyancy tank seating portion 130 of the caisson 110. A separation distance between two adjacent protrusions 160 from among the plurality of protrusions 160 corresponds to the thickness of the partition wall 135 of the buoyancy tank seating portion 130.

In the coupling operation (S20), the caisson (see 110 of FIG. 2) to be constructed prepared through the operation of preparing the caisson (S11) and the buoyancy tank (see 150 of FIG. 3) prepared through the operation of preparing the buoyancy tank (S12) are coupled to each other. FIGS. 4 and 5

show a process in which the caisson 110 to be constructed and the buoyancy tank 150 are coupled to each other through the coupling operation (S20).

First, referring to FIG. 4, the caisson 110 is disposed on a floating dock 170 (or dry dock), and the buoyancy tank 150 floating on the water is located above the buoyancy tank seating portion 130 of the caisson 110. The caisson 110 may be manufactured on land and then transported to the floating dock 170 or manufactured in the floating dock 170. The buoyancy tank 150 is manufactured from the outside of the floating dock 170, and is towed by a tugboat and transported to the floating dock 170, and then positioned on the buoyancy tank seating portion 130 by a winch 180 installed in the floating dock 170. At this time, the rear wall 123 of the caisson 110 and the first wall portion 151 of the buoyancy tank 150 are adjacent to each other. Afterwards, water is supplied to the buoyancy tank 150 and the wall portion 120 of the caisson 110, and the weight of the buoyancy tank 150 increases and sinks down as shown by the arrow, and as shown in FIG. 5, the buoyancy tank 150 is seated on the buoyancy tank seating portion 130 of the caisson 110 and then, the caisson 110 and the buoyancy tank 150 are coupled to each other by a coupling unit 190 so that a caisson assembly 100 is formed. FIG. 6 is a perspective view showing the caisson assembly 100 formed by coupling the caisson 110 and the buoyancy tank 150. Referring to FIGS. 5 and 6 together with FIGS. 2 and 3, in a state in which each of the plurality of protrusions 160 formed in the buoyancy tank 150 is inserted into each of a plurality of seating grooves 136 formed in the buoyancy tank seating portion 130 of the caisson 110, the plurality of protrusions 160 are fixed by a plurality of coupling units 190.

Although not shown, so that the protrusions 160 can be smoothly accommodated in the seating grooves 136 of the caisson 110 in the course of the buoyancy tank 150 descending, the protrusions 160 become narrower toward a lower end (end). A fastening process for the plurality of coupling units 190 after the protrusions 160 are seated on the seating grooves 136 of the caisson 110, is performed.

FIG. 7 shows a fastening state by the coupling unit 190. Referring to FIG. 7, the coupling unit 190 includes a screw rod 191 on which a screw is

formed, and two nut members 192 and 193 respectively coupled to both sides of the screw rod 191. The thread rod 191 with male thread passes through the coupling hole 124 formed in the rear wall 123 of the caisson 110 and the through holes 153 formed in the first wall portion 151 of the buoyancy tank 150.

5 Two nut members 192 and 193 are respectively coupled to the rear wall 123 and the first wall portion 151, and a flat plate member 195 is additionally provided between the first wall portion 151 and the nut member 193. The coupling unit 190 may have a configuration of a general post tension (PT) bar.

10 In the operation of transporting the assembly (S30), the caisson assembly 100 formed through the coupling operation (S20) is transported to a construction site of the caisson 110 to be constructed on the sea. The operation of transporting the assembly (S30) may be performed by towing the caisson assembly 100 floating on the water to the construction site using the tugboat. FIG. 8 shows a state in which the caisson assembly 100 is
15 transported through the operation of transporting the assembly (S30) and located at the construction site P.

20 In the operation of sinking the assembly (S40), the caisson assembly 100 transported to the construction site of the caisson 110 to be constructed through the operation of transporting the assembly (S30) is sunken. In a state in which the caisson assembly 100 is floating on the water at the construction site P, as shown in FIG. 8, the operation of sinking the assembly (S40) is performed by filling water in the inner space 120a of the wall portion 120 of the caisson 110 and the inner space 150a of the buoyancy tank 150 and by increasing the weight of the caisson assembly 100. FIG. 9 shows a
25 constructed state in which the caisson assembly 100 is sunken at the construction site P.

30 In the dismantling operation (S50), the buoyancy tank 150 is separated from the caisson assembly 100 sunken at the construction site through the operation of sinking the assembly (S40). The dismantling operation (S50) is performed by dismantling the plurality of coupling units 190 and removing water filled in the inner space 150a of the buoyancy tank 150. The buoyancy tank 150 separated from the caisson 110 through the disassembly operation (S50)

is raised by buoyancy, as shown in FIG. 10, and is then towed by the tugboat and recycled.

According to the present invention, all of the objects of the present invention described above can be achieved. Specifically, a caisson, which
5 has a wall structure of a smaller volume than the existing caisson, is detachably coupled and moves to a construction site after launching using a reusable buoyancy tank, so that construction cost can be reduced compared to the existing caisson constructing method.

While the present invention has been particularly shown and described
10 with reference to exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the following claims.

What is claimed is:

1. A method for constructing a caisson on the sea using buoyancy, the method comprising:

preparing a caisson to be constructed;

preparing a buoyancy tank, the buoyancy tank being coupled to the caisson to be constructed and providing buoyancy;

coupling the caisson to be constructed to the buoyancy tank on the sea so as to form a caisson assembly; and

transporting the caisson assembly to a construction site of the caisson to be constructed on the sea,

wherein the caisson to be constructed comprises a base portion and a wall portion, the wall portion extending upward from the base portion, positioned adjacent to a front end of the base portion and providing an inner space, and

in the coupling, the buoyancy tank is detachably coupled to the wall portion by a coupling unit;

wherein the caisson to be constructed further comprises a buoyancy tank seating portion for providing a seating space on which the buoyancy tank is seated, and in the coupling, a lower portion of the buoyancy tank is inserted into the seating space and seated thereon; and

wherein the buoyancy tank comprises a plurality of protrusions positioned at a lower portion of the buoyancy tank and protruding downward, and a plurality of seating grooves are formed in the seating space and partitioned by a plurality of partition walls, and in the coupling, each of the plurality of protrusions is inserted into each of the plurality of seating grooves.

2. The method of claim 1, wherein the buoyancy tank in a state of being located above the seating space descends by water supplied to the inner space of the buoyancy tank and is inserted into the seating space.

3. The method of claim 1, wherein the coupling unit has a configuration of a plurality of post tension (PT) bars coupled to adjacent wall surfaces of the wall portion and the buoyancy tank.

4. The method of claim 1, wherein, in the coupling, the buoyancy tank is located closer to a rear end of the base portion than the wall portion and coupled to the wall portion.

5. The method of claim 1, further comprising sinking the caisson assembly by supplying water to the inner space and the buoyancy tank in a state in which the caisson assembly is transported to the construction site through the transporting of the assembly.

6. The method of claim 5, further comprising dismantling the buoyancy tank from the caisson assembly sunken at the construction site through the sinking, wherein the dismantling is performed by draining water from the buoyancy tank in a state in which the coupling unit is dismantled.

7. The method of claim 1, wherein the coupling is performed in a floating dock or dry dock.

8. A caisson assembly for constructing a caisson on the sea using buoyancy, the caisson assembly comprising:

an L-shaped caisson comprising a base portion and a wall portion, the wall portion extending upward from the base portion, positioned adjacent to a front end of the base portion and providing an inner space;

a buoyancy tank coupled to the L-shaped caisson and providing buoyancy;
and

a coupling unit detachably coupling the L-shaped caisson and the buoyancy tank;

wherein the L-shaped caisson further comprises a buoyancy tank seating portion providing a seating space on which a lower portion of the buoyancy tank is seated;
and

wherein the buoyancy tank comprises a plurality of protrusions positioned at a lower portion of the buoyancy tank and protruding downward, and the L-shaped caisson further comprises a plurality of partition walls partitioning the seating space into a plurality of seating grooves, and each of the plurality of protrusions is inserted into each of the plurality of seating grooves.

9. The caisson assembly of claim 8, wherein the coupling unit has a configuration of a plurality of post tension (PT) bars coupled to adjacent wall surfaces of the wall portion and the buoyancy tank.