

BREAKWATER STRUCTURE

Field of the invention

The present disclosure relates to a breakwater structure. More specifically, embodiments disclosed herein generally relate to a breakwater structure which simplifies the construction process, prevents damaging of the breakwater by waves or a high sea in the construction process, constantly reduces the waves and high sea to a stable condition, and provides a time saving to build the breakwater with the simplified construction process.

Background

The statements in this section merely provide background information related to some embodiments of the present disclosure and do not necessarily constitute prior art.

Harbors and coastal areas generally have often mandatory breakwaters installed by a variety of construction methods and different forms.

Earliest breakwaters were built at a height to prevent relatively high waves and they divided the open sea from a blocked inland sea. However, such a breakwater constructed in a way to confine the seawater hindered the natural flow of seawater, and then contaminated the inland body of water in filth and rubbish which became the dominant source of stench in severe cases. The result has been a catastrophic destruction of the ecosystems of foreshores on the inland sea side or seabeds.

Further, the aforementioned breakwater hit by a rushing wave generates a large repulsive force to be added to the subsequent incoming seawater before impacting the breakwater with a greater energy, resulting in ever increasing heights of waves which adversely overflow into the inland sea.

There have been proposed breakwaters of various permeable structures for allowing circulations of seawater to overcome these adverse effects. A

solution has been proposed by Korean Patent No. 770238, entitled "Breakwater Structure" with building unit blocks.

FIG. 1 is a schematic front view of the breakwater which is constructed by utilizing the unit blocks according to the prior art.

Referring to FIG. 1, a unit block for building a breakwater is integrally formed with multiple columns 30 coupling an upper plate 10 and a lower plate 20 to each other. The upper plate 10 and the lower plate 20 are formed with intermeshing protrusions 15 and intermeshing grooves 25.

The breakwater is constructed with a stack of a first layer, a second layer, and so on. The first layer is composed of a frame 50 with intermeshing protrusions 55 and a plurality of unit blocks with their intermeshing grooves 25 receiving the protrusions 55 of the frame 50. The second or upper layer is stacked on the first or lower layer and composed of another plurality of unit blocks in a staggered pattern with respect to the lower layer unit blocks, while the intermeshing protrusions 15 of the lower layer mate with the corresponding grooves 25 of the upper layer. Thus constructed breakwater allows a smooth passing of the tidal currents through the space between the columns of the respective unit blocks.

However, the breakwater structure such as described above is subject to crashing damages at the intermeshing protrusions in its construction process or by thrusts of waves. Such crashing of the protrusions will only aggravate the thrusts of waves and high sea on the unit blocks, resulting in inoperable breakwater.

In addition, once the unit block protrusions are damaged, it is not only a very difficult task to restore the problem unit block out of the completed breakwater structure, but also requires an excessive repair cost.

Moreover, the aforementioned breakwater structure needs considerable time and effort to build because the process of stacking the unit blocks involves the intermeshing of the protrusions one by one.

Prior art

Korean Patent Registration No. 10-0770238 (issued November 6, 2006)

Summary of the invention

Aspects of the disclosure are defined in the appended independent claims.

According to at least one embodiment, a breakwater structure includes a support plate, a plurality of middle plates, a plurality of pillars, a plurality of through-rods and a cover plate. The support plate is configured to be installed on the seabed and to have an upper surface formed with a plurality of grooves. The middle plates are arranged in a plurality of layers, wherein each middle plate is configured to have an upper surface and a lower surface formed with a plurality of grooves and a plurality of through-holes penetrating from the upper surface to the lower surface so that the grooves and the through-holes are aligned vertically above or below each other. The pillars are configured to be installed vertically between the support plate and an lowermost middle plate out of the plurality of middle plates and between the plurality of middle plates positioned one above the other so that the pillars extend in alignment with correspondingly opposing grooves of the middle plates. The through-rods are each configured to pass vertically through the middle plates and have one end fixed to the support plate. And the cover plate is configured to be stacked on an uppermost middle plate of the plurality of middle plates and to fix upper ends of the through-rods.

The breakwater structure may further include a tie rod configured to supportively interconnect at least two of the pillars.

The tie rod may be configured to be placed in parallel with at least one of the middle plate.

The tie rod may be configured to be installed obliquely across the plurality of pillars from one pillar at an upper portion to another pillar at a lower portion.

According to another embodiment, a breakwater structure includes a support plate, a plurality of middle plates, a plurality of pillars, a cover plate and a tie rod. The support plate is configured to be installed on the seabed and to have an upper surface formed with a plurality of grooves. The middle plates are

arranged in a plurality of layers, wherein each middle plate is configured to have an upper surface and a lower surface formed with a plurality of grooves aligned vertically above or below each other. The pillars are configured to be installed vertically between the support plate and an lowermost middle plate out of the plurality of middle plates and between the plurality of middle plates positioned one above the other so that the pillars extend in alignment with correspondingly opposing grooves of the middle plates. The cover plate is configured to be stacked on an uppermost middle plate of the plurality of middle plates. And the tie rod is configured to extend between corresponding middle plates in at least one of the layers, to supportively interconnect at least two of the pillars, and to extend in parallel with the middle plates.

According to yet another embodiment, a breakwater structure includes a support plate, a plurality of middle plates, a plurality of pillars, a cover plate and at least one tie rod. The support plate is configured to be installed on the seabed and to have an upper surface formed with a plurality of grooves. The middle plates are arranged in a plurality of layers, wherein each middle plate is configured to have an upper surface and a lower surface formed with a plurality of grooves aligned vertically above or below each other. The pillars are configured to be installed vertically between the support plate and an lowermost middle plate out of the plurality of middle plates and between the plurality of middle plates positioned one above the other so that the pillars extend in alignment with correspondingly opposing grooves of the middle plates. The cover plate is configured to be stacked on an uppermost middle plate of the plurality of middle plates. And the tie rod is configured to extend between corresponding middle plates in at least one of the layers, to supportively interconnect at least two of the pillars obliquely across the plurality of pillars from one pillar at an upper portion to another pillar at a lower portion.

Brief description of the drawings

Embodiments of the present disclosure will now be described to the accompanying drawings in which:

FIG. 1 is a diagram of a prior art breakwater structure constructed by using unit blocks.

FIG. 2 is a perspective view of a breakwater structure according to at least one embodiment of the present disclosure.

FIG. 3 is an exemplary perspective view of an middle plate shown in FIG. 2.

FIG. 4 is a cross-sectional view of the middle plate shown in FIG. 3 taken along line A-A'.

FIG. 5 is an exemplary perspective view of a pillar shown in FIG. 2.

FIG. 6 is an exemplary perspective view of a joint structure of pillars and a tie rod.

FIG. 7 is another exemplary perspective view of a joint structure of pillars and tie rods.

FIG. 8 is a perspective view of a breakwater structure according to another embodiment of the present disclosure.

In the figures like reference numerals referred to like parts.

Detailed description of the drawings

The present disclosure has been made in view of the above to simplify the breakwater construction process, prevent damaging of the breakwater by the waves or high sea, constantly reduce the waves and high sea to a stable condition, and provide a time saving to build the breakwater with the simplified construction process.

A breakwater structure according to some embodiments will now be described more fully with reference to the accompanying drawings.

Turning to FIG. 2, a breakwater structure 100 according to at least one embodiment is illustrated.

The breakwater structure 100 includes a support plate 110, a plurality of pillars 120, a plurality of middle plates 130, a barrier wall 140, a cover plate 150 and a plurality of through-rods 160. The breakwater structure 100 further includes tie rods 170 which will be described below.

The support plate 110 is installed on the seabed and has a plurality of grooves formed on the top surface thereof. Here, the support plate 110 may be stacked on a foundation layer 102. Here, the foundation layer 102 is made in a foundation work of the seabed to flatten the seafloor terrain, and formed with a top recess for securely mounting the support plate 110. The foundation layer 102 may include a riprap foundation among a variety of other formations. In addition, after being overlaid with the support plate 110, the foundation layer 102 may have a riprap protection 104 formed thereon for covering the foundation layer 102 as well as securing the support plate 110 in place.

The foundation layer 102 may be installed after digging a groove of a predetermined depth in the sea bottom, or it may be installed with at least one downward anchor post which is driven into the sea bottom and thereby fixes the foundation layer 102 to the sea bottom and provides a substantially flat top surface over the foundation layer 102. The foundation layer 102 may also be provided with fixing grooves or fixing protrusions for fixing the support plate 110 on its upper surface. Or, the support plate 110 may also be integrally formed with the foundation layer 102 and the riprap protection 104. However, installing the support plate 110 is not intended to be limited to the described methods, and it can also be installed in a variety of modified manners. The support plate 110 may be made of concrete, but it is not limited thereto, and may be made by utilizing various materials.

The multiple pillars 120 may be installed vertically between the support plate 110 and the lowermost one of the middle plates 130, between the respective middle plates 130, and between the uppermost middle plate 130 and the cover plate 150, fitting into the respectively opposing grooves formed on all of the above plates.

Referring to FIGs. 3 and 4, the multiple middle plates 130 include a plurality of grooves 132 formed on the upper and lower surfaces, and a plurality of through holes 134 penetrating from the upper surface to lower surface, and the middle plates 130 are stacked into a multilayered structure so that each of the grooves 132 and each of the through-holes 134 are located vertically above the others. Specifically, when viewed at the cross-section taken along line A-A', each middle plate 130 has the plurality of grooves 132 formed on the upper and lower surfaces, and the plurality of through holes 134 penetrating from the upper surface to lower surface. At this time, each middle plate 130 is provided with the grooves 132 colocated latitudinally and extending in the opposite directions on the upper and lower surfaces, respectively, and the grooves 132 are preferably formed to alternate with the through-holes 134 at a set interval lengthwise and breadthwise. Alternatively, the grooves 132 formed on the upper and lower surfaces of each middle plate 130 may be located out of longitudinal alignment. Likewise, the support plate 110 is desirably formed with grooves at the same interval as that of the grooves 132 formed on each middle plate 130. The multilayered structure is established by stacking layers of the middle plates 130 with their grooves 132 and through-holes 134 vertically aligned and inserting the multiple pillars 120 in the grooves 132, respectively. In this case, the multiple pillars 120 each has a cylindrical shape of a predetermined height as shown in FIG. 5 and is insertable in the grooves of the support plate 110 and the grooves 132 of the middle plates 130. To this end, the grooves of the support plate 110 and the grooves 132 of the middle plates 130 are formed as cylindrical recesses having a predetermined diameter, and in this connection, each pillar 120 has a diameter preferably smaller than that of the grooves of the support plate 110 and the grooves 132 of the middle plates 130.

The barrier wall 140 is adapted to vertically upward from the top surface of uppermost middle plate 130 of the plurality of middle plates 130. In other words, the barrier wall 140 may be placed vertically upward on the top surface of the at least one middle plate 130 that is placed on top. In this case, the barrier wall 140 may be formed in the manufacturing process integrally with the middle plate 130

to be placed atop the layers of the middle plates 130. This provides the best possible protection against waves or a high sea attempting to verflow into the inland sea.

With a plurality of pillars 120 set up perpendicular to the top surface of the uppermost middle plate 130 over the plurality of middle plates 130, the cover plate 150 may be stacked on the pillars 120 and the barrier wall 140. Here, the cover plate 150 may be made of, but not limited to, concrete, and can use various materials to manufacture. For example, the cover plate 150 may be formed with a transparent acrylic plate of a predetermined thickness, and thereby may also be implemented to render seawater to be visible as it travels inside the breakwater. Such cover plates 150 block seawater from rising from the inside of the breakwater structure while serving as sidewalks and driveways.

The through-rods 160 are configured to extend vertically through the respective middle plates 130 and have their first ends fixed to the upper surface of the support plate 110 and their second ends fixed to the lower surface of the cover plate 150. In this case, the through-rods 160 are preferably installed so as to vertically penetrate the respective middle plates 130 at their corner portions. However, the installing positions of the through-rods 160 are not intended to be limited to the described embodiment, and by taking into account of the size of the middle plates 130, additional through-rods 160 may be installed on the respective sides of each middle plate 130.

In embodiments, the tie rod 170 connects and supports two or more pillars 120 to each other. In this case, the tie rod 170 may supportively connect the pillars 120 in a direction parallel to the middle plates 130, as shown in FIG. 6. In other words, the tie rod 170 groups two or more pillars 120 by connecting the respective pillars 120 installed between the opposing middle plates 130 in parallel therewith. The pillars 120 and the tie rod 170 may be configured to mate directly or by using two or more fasteners 172 at their contact portions. Here, the fastener 172 includes wire, chain and any other members such as screws and rivets.

Alternatively, a tie rod 170 may extend obliquely from one pillar 120 at its upper portion to a lower portion of a second pillar 120, to interconnect the two or more pillars 120. In this case, another tie rod 170 is preferably used to obliquely interconnect the second pillar 120 at its upper portion with a lower portion of the first pillar 120. At this time, the intersections of the tie rods 170 with the pillars 120 may be fixed by using the fasteners 172. In this case, one of the tie rods 170 may be coupled to the rear sides of the respective pillars 120 and the other tie rod 170 may be coupled to the front sides of the pillars 120. This grouping of multiple pillars 120 with the tie rods 170 modularizes the multiple pillars 120 by groups in preparation for the installation between the middle plates 130, and thereby simplifies and expedites the building process of the breakwater.

According to some embodiments of the present disclosure, the breakwater structure has the middle plates provided with through-holes for allowing seawater to pass up and down and to flow to and from the open sea and inland sea.

FIG. 8 shows a breakwater structure according to another embodiment of the present disclosure.

Referring to FIG. 8, the breakwater structure 200 according to another embodiment of the present disclosure includes a support plate 210, a plurality of pillars 220, a plurality of middle plates 230, a barrier wall 240, a cover plate 250 and through-rods 260. Here, the support plate 210, pillars 220 and barrier wall 240 have the equal or similar configurations and functions to those of the support plate 110, pillars 120 and barrier wall 140 as illustrated in FIG. 2, and detailed descriptions thereof are omitted. However, the middle plates 230 and the cover plate 250 may have a plurality of semicylindric formations on their sides facing towards inland sea, which is different from the middle plates 130 and the cover plate 150 in FIG. 2. Alternatively, the middle plates 130 and the cover plate 150 in FIG. 2 may be incorporated in the embodiment with cylindrical pillars erected from the support plate 210, extending in proximal contact with the middle plates 130 and the cover plate 150 on their sides facing towards the inland sea. This allows ships a convenient access to the breakwater structure from the inland sea. In addition, the respective pillars 220 may be interconnected by at least one tie

rod 170 as shown in FIGs. 6 and 7 with the multiple pillars 220 modularized by groups in preparation for the installation on the middle plates 230 in the building process of the breakwater.

According to some embodiments as described above, the construction process of a breakwater structure is carried out at once for simplification and prevents damaging of the breakwater under construction by waves or a high sea.

In addition, the breakwater structure of the present disclosure can not only effectively and efficiently suppress the waves and high sea from approaching the inland sea from the open sea, but also permits the free flow of seawater between the open sea and inland sea to keep seawater from being contaminated.

Further, according to some embodiments, the component middle plates are respectively affixed with the through-rods which are respectively interconnected by tie rods, so as to maintain the middle plates against possible displacements by seawater.

Furthermore, according to some embodiments, the multiple pillars are grouped into modules for installation between the middle plates, and thereby simplifies and expedites the building process of the breakwater.

Claims

1. A breakwater structure, comprising:
 - a support plate configured to be installed on the seabed and to have an upper surface formed with a plurality of grooves;
 - a plurality of middle plates arranged in a plurality of layers, each middle plate being configured to have an upper surface and a lower surface formed with a plurality of grooves and a plurality of through-holes penetrating from the upper surface to the lower surface so that the grooves and the through-holes are aligned vertically above or below each other;
 - a plurality of pillars configured to be installed vertically between the support plate and an lowermost middle plate out of the plurality of middle plates and between the plurality of middle plates positioned one above the other so that the pillars extend in alignment with correspondingly opposing grooves of the middle plates;
 - a plurality of through-rods each configured to pass vertically through the middle plates and have one end fixed to the support plate; and
 - a cover plate configured to be stacked on an uppermost middle plate of the plurality of middle plates and to fix upper ends of the through-rods.
2. A breakwater structure as claimed in claim 1 further comprising a tie rod configured to supportively interconnect at least two of the pillars.
3. A breakwater structure as claimed in claim 2 wherein the tie rod is configured to be placed in parallel with at least one of the middle plate.
4. A breakwater structure as claimed in claim 2 wherein the tie rod is configured to be installed obliquely across the plurality of pillars from one pillar at an upper portion to another pillar at a lower portion.
5. A breakwater structure, comprising:

a support plate configured to be installed on the seabed and to have an upper surface formed with a plurality of grooves;

a plurality of middle plates arranged in a plurality of layers, each middle plate being configured to have an upper surface and a lower surface formed with a plurality of grooves aligned vertically above or below each other;

a plurality of pillars configured to be installed vertically between the support plate and an lowermost middle plate out of the plurality of middle plates and between the plurality of middle plates positioned one above the other so that the pillars extend in alignment with correspondingly opposing grooves of the middle plates;

a cover plate configured to be stacked on an uppermost middle plate of the plurality of middle plates; and

a tie rod configured to extend between corresponding middle plates in at least one of the layers, to supportively interconnect at least two of the pillars, and to extend in parallel with the middle plates.

6. A breakwater structure, comprising:

a support plate configured to be installed on the seabed and to have an upper surface formed with a plurality of grooves;

a plurality of middle plates arranged in a plurality of layers, each middle plate being configured to have an upper surface and a lower surface formed with a plurality of grooves aligned vertically above or below each other;

a plurality of pillars configured to be installed vertically between the support plate and an lowermost middle plate out of the plurality of middle plates and between the plurality of middle plates positioned one above the other so that the pillars extend in alignment with correspondingly opposing grooves of the middle plates;

a cover plate configured to be stacked on an uppermost middle plate of the plurality of middle plates; and

at least one tie rod configured to extend between corresponding middle plates in at least one of the layers, to supportively interconnect at least two of the

pillars obliquely across the plurality of pillars from one pillar at an upper portion to another pillar at a lower portion.