

【SPECIFICATION】

【Title of the Invention】

Breakwater structure and construction method of the same

【Technical Field】

5 **[0001]** Exemplary embodiments of the invention relate to a breakwater structure and construction method of the breakwater structure. More particularly, exemplary embodiments of the invention relate to a breakwater structure capable of preventing damage due to waves and construction method of the breakwater structure.

【Background Art】

10 **[0002]** Generally, a breakwater is essentially constructed at a harbor or a waterfront. The breakwater may have various shape and structure for construction. A traditional breakwater has enough height to prevent high waves, so that inland sea and offshore are blocked by the breakwater. However, the traditional breakwater blocks flow of sea between the inland sea and offshore, so that inland sea is easy to be contaminated and it may
15 cause sewage and odor problems. Accordingly, ecosystem of the inland sea, foreshore and undersea may be destroyed.

[0003] In addition, waves may hit the traditional breakwater and goes back to another waves to form higher waves which have higher energy, so that wave height may be increased and finally the waves may pass the breakwater.

20 **[0004]** To solve these problems, breakwaters which have various structures to make it possible that seawater flows between inland sea and offshore may have been proposed.

[0005] For example, according to KR 10-770238, a plurality of unit blocks are stacked to construct a breakwater. Here, the unit block has an upper plate and a lower plate which are integrally formed by a plurality of column, and a jaw and a groove for combination are
25 formed at an upper surface of the upper plate and a lower surface of the lower plate.

[0006] Here, each of the jaw and groove of the unit block may be combined with groove and jaw of another unit block in a vertical direction. Seawater may flow through a space between columns of the unit block.

[0007] However, the jaw and the groove of the unit block may be damaged during construction process or high waves. When the jaw or the groove of the unit block is damaged, movement of the unit block by the waves may be increased. Thus, the breakwater may not properly work.

[0008] In addition, When the jaw or the groove of the unit block is damaged, it is hard to fix the specific broken unit block, and it may cause high maintenance cost.

【Disclosure of the Invention】

【Problem to be solved】

[0009] One or more exemplary embodiment of the invention provides a breakwater structure which is capable of flow of sea water between inland sea and offshore and construction method of the breakwater structure.

[0010] One or more exemplary embodiments of the invention also provide a breakwater structure which is capable of preventing damage due to waves during construction process or after construction and a construction method of the breakwater structure.

[0011] One or more exemplary embodiments of the invention also provide a breakwater structure capable of easy construction and easy maintenance and a construction method of the breakwater structure.

【Technical Solution】

[0012] According to an exemplary embodiment of the invention, a breakwater structure includes a supporting plate which is constructed undersea, a block layer including a plurality of unit blocks which are stacked on the supporting plate, and an insert bar combined through

the block layer in a vertical direction. The unit block includes upper and lower plates having rectangle or square shape and spaced apart each other in the vertical direction, a supporting part formed between the upper and lower plates and having a column shape which is perpendicular to the upper and lower plates, an insert hole formed at each of the upper and lower plates in which the insert bar is inserted, wherein the insert holes of the upper and lower plates are corresponding to each other, and a combining groove formed at each of edge of the upper and lower plates.

[0013] In an exemplary embodiment, the long side may be n -times longer than short side (here, n is 2 or natural number greater than 2) when the upper and lower plates have rectangle shape. The combining groove may be formed at each of $(2k-1)/2n$ point of the long side (here k is an integer that increases by 1 from 1 to n) and $1/2$ point of the short side of each of the upper and lower plates.

[0014] In an exemplary embodiment, when the long side may be twice of the short side, an arc shaped incision portion may be formed at a vertex of a corner of the upper and lower plates or $1/2$ point of the long side as a center or the arc shape.

[0015] In an exemplary embodiment, when each of the upper plate and the lower plate may have square shape. The combining groove may be formed at $1/2$ point of each of sides of the square shape.

[0016] In an exemplary embodiment, an arc shaped incision portion may be formed at a vertex of a corner of the upper and lower plate.

[0017] In an exemplary embodiment, the a plurality of the unit blocks may be arranged in a same plane to form a unit layer. The combining grooves of the unit blocks adjacent to each other may make contact with each other. A plurality of unit layers may be stacked in the vertical direction to form the block layer.

[0018] In an exemplary embodiment, the breakwater structure may further include a

combining part inserted into the combining groove to combine a pair of the unit blocks adjacent each other.

[0019] In an exemplary embodiment, the combining part may include a pair of combining portions having a bar shape, spaced apart from and in parallel with each other, and a
5 connecting portion which connects middle of the combining portions each other.

[0020] In an exemplary embodiment, a plurality of the unit blocks may be alternately arranged in a perpendicular direction in a same plane. When the long side of the rectangular shape unit block may be twice of the short side, the long side of the rectangular shape unit block may be located to make contact with two half of long sides of another
10 rectangular shape unit blocks, or contact with two short side of another rectangular shape unit blocks, contact with one short side of another rectangular shape unit block and one side of square shape unit block, or contact with one short side of another rectangular shape unit block and a side of square shape unit block.

[0021] In an exemplary embodiment, the unit block may further include a middle plate
15 which is disposed between the upper plate and the lower plate in parallel with the upper and the lower plates and supported by the supporting part. An insert hole in which the insert bar is inserted may be formed at a side of the middle plate. At least one combining groove may be formed along an edge thereof.

[0022] In an exemplary embodiment, the unit block may further include a plurality of
20 semi-cylinders protruded from an edge of the upper plate to an edge of the lower plate. The semi-cylinders may be formed along a length direction and spaced apart from each other.

[0023] In an exemplary embodiment, the unit block further may further include a blocking wall formed along edges of the upper and lower plate which is opposite to the
25 semi-cylinders

[0024] In an exemplary embodiment, the unit block may further include a blocking wall formed on a surface which is perpendicular to the edge on which the semi-cylinders are formed.

[0025] In an exemplary embodiment, the supporting part may extend from the insert hole of the upper plate to the insert hole of the lower plate. The insert hole may be formed through the supporting part in a length direction of the supporting part.

[0026] In an exemplary embodiment, the unit block may further include a middle plate, a plurality of semi-cylinders and a blocking wall. The middle plate may be disposed between the upper plate and the lower plate in parallel with the upper and the lower plates.

Each of the semi-cylinders may be protruded from an edge of the upper plate to an edge of the lower plate. The semi-cylinders may be formed along a length direction and spaced apart from each other. The blocking wall may be formed along edges of the upper and middle plates which are opposite to the semi-cylinders

[0027] In an exemplary embodiment, the unit block may further include a middle plate, a plurality of semi-cylinders and a blocking wall. The middle plate may be disposed between the upper plate and the lower plate in parallel with the upper and the lower plates.

Each of the semi-cylinders may be protruded from an edge of the upper plate to an edge of the lower plate. The semi-cylinders may be formed along a length direction and spaced apart from each other. The blocking wall may be formed along edges of the middle and

lower plates which are opposite to the semi-cylinders.

[0028] In an exemplary embodiment, the insert hole may have a polygonal shaped cross-section.

[0029] According to an exemplary embodiment of the invention, a breakwater structure includes a supporting plate which is constructed undersea, and a block layer comprising a plurality of unit blocks which are stacked on the supporting plate. The unit block includes

upper and lower plates spaced apart each other in the vertical direction, a supporting part formed between the upper and lower plates, and having a column shape which is perpendicular to the upper and lower plates, a combining groove formed on a upper plate, and a locking portion protruded upward from a bottom surface of the combining groove.

5 **[0030]** In an exemplary embodiment, the combining groove may include a first combining groove formed along an edge of the upper plate.

[0031] In an exemplary embodiment, the combining groove may further include a second combining groove formed at middle of the upper plate.

[0032] In an exemplary embodiment, the breakwater structure may further include a insert
10 groove formed along an edge of the lower plate corresponding to the first combining groove.

[0033] In an exemplary embodiment, the breakwater structure may further include a combining part inserted in the combining groove configured to combine a pair of the unit blocks which are disposed adjacent to each other.

[0034] In an exemplary embodiment, the combining part may include a first combining part
15 which combines a pair of the unit blocks which are stacked in the vertical direction, and a second combining part which combines a pair of the unit blocks which are disposed adjacent to each other in a same plane.

[0035] In an exemplary embodiment, the first combining part may include a seating portion inserted into the combining groove, and configured to be locked by the locking portion, and
20 an insert portion protruded from the seating portion, inserted into the inserting groove of the unit block at a upper layer, and supported by lower plate of the unit block at the upper layer.

[0036] In an exemplary embodiment, the seating portion may have C-shape, U-shape or arc shape. Both ends of the insert portion may be vertically extended from both ends of the seating portion.

25 **[0037]** In an exemplary embodiment, the second combining part may have quadrangle

shape, oval shape or circular ring shape.

[0038] In an exemplary embodiment, the unit block may further include a plurality of semi-cylinders protruded from an edge of the upper plate to an edge of the lower plate. The semi-cylinders may be formed along a length direction and spaced apart from each other.

[0039] In an exemplary embodiment, the unit block may further include a blocking wall opposite to the semi-cylinders.

[0040] In an exemplary embodiment, the breakwater structure may further include a locking groove formed at a lower portion of the blocking wall.

[0041] According to an exemplary embodiment of the invention, a construction method of a breakwater structure includes (a) forming a supporting plate under the seafloor, (b) forming a block layer by stacking unit layers each of which includes a plurality of unit blocks on the supporting plate in a same plane, and (c) seating a cover plate to cover a top layer or the block layer. In the (b), a pair of unit blocks adjacent to each other are combined by a combining part.

[0042] In an exemplary embodiment, in the (b), a pair of unit blocks which are stacked in a vertical direction may be combined with each other by a first combining part. A pair of unit blocks which are disposed adjacent to each other in a same plane may be combined with each other by a second combining part.

[0043] In an exemplary embodiment, in the (b), the unit block may include upper and lower plates spaced apart each other in the vertical direction, a supporting part formed between the upper and lower plates, and having a column shape which is perpendicular to the upper and lower plates, a combining groove formed on a upper plate, a locking portion protruded upward from a bottom surface of the combining groove, and an insert hole formed along an edge of the lower plate and formed through the lower plate in the vertical direction.

[0044] In an exemplary embodiment, in the (b), the combining part may include a seating portion having C-shape, U-shape or arc shape, and an insert portion protruded from both ends of the seating portion, upper portions of the insert portion are connected to each other. The seating portion may be inserted in the combining groove of the unit block at a lower layer configured to be locked by the locking portion. The insert portion may be inserted in the combining groove of the unit block at an upper layer configured to be supported by the lower plate of the unit block at the upper layer.

[0045] In an exemplary embodiment, in the (b), the combining groove may have C-shape, U-shape or arc shape along an edge of the upper plate. When the unit block are arranged in a horizontal direction, the combining part may be inserted in a pair of combining grooves symmetrically disposed adjacent to each other with being locked by the locking portion.

【Effect of the Invention】

[0046] According to the present invention, sea water between inland sea and offshore may flow through unit blocks of the breakwater structure.

[0047] In addition, damage or slip of the unit block of the breakwater structure by a wave may be presented during or after constriction according to the breakwater structure and the construction method of the breakwater structure.

[0048] In addition, construction and maintenance are easy according to the breakwater structure and the construction method of the breakwater structure.

【Brief Description of Drawings】

[0049] The above and other features of the invention will become more apparent by describing in detail exemplary embodiments thereof with reference to the accompanying drawings, in which:

[0050] FIG. 1 is an exploded perspective view illustrating a breakwater structure according to a first embodiment of the invention;

[0051] FIG. 2 is a perspective view illustrating a rectangle unit block according to the first embodiment;

[0052] FIG. 3 is a perspective view illustrating a square unit block according to the first embodiment;

5 **[0053]** FIG. 4 is a plan view illustrating a unit layer according to the first embodiment;

[0054] FIG. 5 is a front view illustrating a plurality of unit layers which are stacked according to the first embodiment;

[0055] FIG. 6 is a plan view illustrating a unit layer according to a second embodiment of the invention;

10 **[0056]** FIG. 7 is a front view illustrating a plurality of unit layers which are stacked according to the second embodiment;

[0057] FIG. 8 is a perspective view illustrating a rectangle unit block according to a third embodiment of the invention;

15 **[0058]** FIG. 9 is a perspective view illustrating a square unit block according to the third embodiment;

[0059] FIGS. 10 and 11 are perspective views illustrating a rectangle unit block according to a fourth embodiment of the invention;

[0060] FIG. 12 is a perspective view illustrating a square unit block according to the fourth embodiment;

20 **[0061]** FIGS. 13 and 14 are perspective views illustrating a rectangle unit block according to a fifth embodiment of the invention;

[0062] FIG. 15 is an exploded perspective view illustrating a breakwater structure which is constructed using the rectangle unit blocks according to the fifth embodiment;

25 **[0063]** FIG. 16 is a perspective view illustrating a rectangle unit block according to a sixth embodiment of the invention;

[0064] FIG. 17 is a perspective view illustrating a square unit block according to the sixth embodiment;

[0065] FIG. 18 is a perspective view illustrating a rectangle unit block according to a seventh embodiment of the invention;

5 **[0066]** FIG. 19 is a perspective view illustrating a square unit block according to the seventh embodiment;

[0067] FIG. 20 is a perspective view illustrating a rectangle unit block according to an eighth embodiment of the invention;

10 **[0068]** FIG. 21 is a perspective view illustrating a square unit block according to the eighth embodiment;

[0069] FIG. 22 is a perspective view illustrating a rectangle unit block according to a ninth embodiment of the invention;

[0070] FIG. 23 is an exploded perspective view illustrating a breakwater structure according to a tenth embodiment;

15 **[0071]** FIG. 24 is a perspective view illustrating a first block layer of the breakwater structure according to the tenth embodiment;

[0072] FIGS. 25 and 26 are perspective views illustrating a rectangle unit block of the first block layer according to the tenth embodiment;

20 **[0073]** FIGS. 27 and 28 are perspective views illustrating a square unit block of the first block layer according to the tenth embodiment;

[0074] FIG. 29 is a perspective view illustrating a second block layer of the breakwater structure according to the tenth embodiment;

[0075] FIGS. 30 and 31 are perspective views illustrating a rectangle unit block of the second block layer according to the tenth embodiment;

25 **[0076]** FIGS. 32 and 33 are perspective views illustrating a square unit block of the second

block layer according to the tenth embodiment;

[0077] FIG. 34 is a perspective view illustrating a third block layer of the breakwater structure according to the tenth embodiment;

[0078] FIGS. 35 and 36 are perspective views illustrating a rectangle unit block of the third block layer according to the tenth embodiment;

[0079] FIGS. 37 and 38 are perspective views illustrating another example of a rectangle unit block of the third block layer according to the tenth embodiment;

[0080] FIGS. 39 and 40 are perspective views illustrating a square unit block of the third block layer according to the tenth embodiment;

[0081] FIG. 41 is a perspective view illustrating a first combining part according to the tenth embodiment;

[0082] FIG. 42 is a perspective view illustrating a second combining part according to the tenth embodiment; and

[0083] FIG. 43 is perspective view illustrating use of the first and second combining parts according to the tenth embodiment.

【Detailed Description of the Invention】

[0084] Hereinafter, the invention will be explained in detail with reference to the accompanying drawings. The present invention may, however, be embodied in many different forms and should not be construed as limited to the example embodiments set forth herein and shown in accompanying drawings. The same reference numerals will be used to refer to the same or like parts.

[0085] First embodiment

[0086] FIG. 1 is an exploded perspective view illustrating a breakwater structure according to the first embodiment of the invention.

[0087] Referring to FIG. 1, a breakwater structure 100 according to the first embodiment

includes a supporting plate 200 which is constructed undersea, a block layer 400 including a plurality of unit blocks 300 which are stacked on the supporting plate 200, and an insert bar 500 combined through the block layer 400 along in a vertical direction.

[0088] Here, the supporting plate 200 may be constructed undersea, and may be stacked on a foundation ground 600. The supporting plate 200 may be consist of one plate, or the supporting plate 200 may include a plurality of blocks which are arranged in a plane to form a plate. The foundation ground 600 may be formed by foundation work on seafloor, and may improve flatness of the seafloor. In addition, seating groove (not shown) or fixing jaw (not shown) may be formed on an upper surface of the foundation ground 600 to filmy fix the supporting plate 200. In addition, after stacking the supporting plate 200 on the foundation ground 600, a cap stone 700 may be formed on both side of the supporting plate 200 to cover or support the both side of the supporting plate 200.

[0089] The foundation ground 600 may be constructed under the seafloor by a predetermined depth, or foundation ground 600 may be constructed by inserting fixing bar (not shown) protruded downward from a bottom surface thereof. Here, the seating groove or the fixing jaw to fix the supporting plate 200 may be formed on the upper surface of the foundation ground 600 as described above.

[0090] The supporting plate 200 may be integrally formed with the foundation ground 600 and the cap stone 700. However, constructing method of the supporting plate 200 is not limited thereto, and various modifications may be possible. In addition, the supporting plate 200 may be formed by a concrete. However, the material of the supporting plate 200 is not limited thereto, and variety of materials may be used for forming the supporting plate 200.

[0091] A plurality of unit blocks 300 are stacked on the supporting plate 200 to form the block layer 400. The block layer 400 may block wave from offshore to reduce energy of

the wave, and makes it possible that natural flow of sea water between offshore and inland sea.

[0092] In addition, the insert bar 500 may be combined through the block layer 400 along the vertical direction. The insert bar 500 may prevent movement of or damage on the block layer 400 from the wave. Here, an insert groove 210 is formed on the upper surface of the supporting plate 200 configured to receive a lower portion of the insert bar 500.

[0093] In addition, a cover plate 800 may be seated on the block layer 400. The cover plate 800 may prevent flow out of sea water from the breakwater structure 100, and may provide sidewalk or road to pass through.

[0094] Here, the cover plate 800 may be formed by a concrete. However, the material of the cover plate 800 is not limited thereto, and variety of materials may be used for forming the cover plate 800. For example, the cover plate 800 may be a transparent acrylic plate having a predetermined thickness. Accordingly, flow of sea water through the breakwater structure 100 may be visible.

[0095] FIG. 2 is a perspective view illustrating a rectangle unit block according to the first embodiment.

[0096] Each of the unit blocks 300 of the block layer 400 according to the first embodiment includes an upper plate 310, a lower plate 320 and at least one supporting part 340 disposed on the lower plate 320 to support the upper plate 310. The upper plate 310 has a shape substantially same as the lower plate 320, and is spaced apart from the lower plate 320 in a vertical direction by the supporting part 340 which has a column shape. Here, that the upper plate 310 and the lower plate 320 have same shape means that each of width and length is same, so that thickness of the upper plate 310 and thickness of the lower plate 320 may be same or different each other.

[0097] In addition, at least one insert hole 350 through the vertical direction is formed at

the upper plate 310 and the lower plate 320. The insert bar 500 is inserted into the insert hole 350, so that the unit blocks which are stacked may be prevented from being moved.

[0098] Here, the insert bar 500 may be inserted into each of the insert holes 350, or the insert bar 500 may be inserted into at least one insert hole 350 which is selected if necessary.

5 In addition, the insert bar 500 may be inserted through the insert hole 350 of the unit block 300 which locates on top layer, through the insert hole 350 of the unit block 300 which locates on bottom layer, and into the insert groove 210 of the supporting plate 200. In addition, the insert bar 500 may be inserted through at least two insert holes 350.

[0099] Referring to FIG. 2, each of the upper plate 310 and the lower plate 320 of the unit
10 block 300 may have rectangular shape having a long side and a short side. The long side may be n-times longer than short side (here, n is 2 or natural number greater than 2).

[00100] Here, a combining groove 360 is formed at $(2k-1)/2n$ point of the long side (here k is an integer that increases by 1 from 1 to n) and $1/2$ point of the short side of each of the upper plate 310 and the lower plate 320. For example, as described in FIG. 2, when the
15 long side is twice of the short side, the combining grooves 360 are formed at $1/4$ point of the long side and at $3/4$ point of the long side, and at $1/2$ of the short side, respectively.

[00101] Here, the combining groove 360 may be formed from and extended in a perpendicular direction to edge of the upper plate 310 and the lower plate 320. Width, length and depth of the combining groove 360 may be properly designed as required.

20 **[00102]** In addition, for circulation of the sea water in the vertical direction, at least one arc shape incision portion 370 is formed at an edge of the upper plate 310 and the lower plate 320. For example, as described in FIG. 2, when the long side is twice of the short side, the arc shape incision portion 370 may be formed at least one point among vertexes of corners and $1/2$ point of the long side as a center of the arc shape.

25 **[00103]** FIG. 3 is a perspective view illustrating a square unit block according to the first

embodiment.

[00104] The unit blocks 300 having a square shape according to the first embodiment includes an upper plate 310, a lower plate 320 and at least one supporting part 340 between the lower plate 320 and the upper plate 310 like that of FIG. 2. Insert holes 350 are formed
5 through the upper plate 310 and the lower plate 320, respectively.

[00105] However, the unit block 300 has same length of sides unlike the rectangle shape unit block of FIG. 2. Here, length of each of the side of the square shape unit block 300 may preferably be same as the short side of the rectangle shape unit block.

[00106] A combining groove 360 is formed at 1/2 point of each of the side of the square
10 shape unit block 300. Size and shape of the combining groove 360 are same as those of the rectangle shape unit block of FIG. 2. In addition, an arc shape incision portion 370 having a predetermined diameter is formed at a vertex of a corner.

[00107] In addition, the unit block 300 of FIG. 2 or 3 may further include at least one middle plate 330 between the upper plate 310 and the lower plate 320.

[00108] The middle plate 330 may have size and shape substantially same as those of the
15 upper plate 310 and the lower plate 320. The middle plate 330 is formed between the upper plate 310 and the lower plate 320 in parallel with the upper and lower plates 310 and 320, and is supported by the supporting part 240. Here, thickness of the middle plate 330 may be same or different from that of the upper plate 310 or the lower plate 320. The
20 insert hole 350 and the incision portion 370 may be formed corresponding to the upper plate 310 and the lower plate 320, and the combining groove 360 may be emitted.

[00109] Although the supporting part 340 is spaced apart from the insert hole 350 by a predetermined distance according to FIGS. 2 and 3, the supporting part 340 may be formed at a same position of the insert hole 350 in some example embodiment. Here, the
25 supporting part 340 has a bigger diameter than that of the insert hole 350, and a hole (not

shown) is formed at a center of the supporting part 340 along a length direction through the insert hole 350 configured to insert the insert bar 500 therein.

[00110] FIG. 4 is a plan view illustrating a unit layer according to the first embodiment. FIG. 5 is a front view illustrating a plurality of unit layers which are stacked according to the first embodiment.

[00111] The unit layer 410 according to the first embodiment may be one layer including a plurality of unit blocks 300 arranged in a same plane. The plurality of unit layers 410 are stacked in a vertical direction to form the block layer 400.

[00112] Each of the combining grooves 360 of the unit blocks 300 is arranged in a same plane with contacting each other. Here, a combining part 900 having a bar shape is inserted in the combining groove 360, so that the unit blocks 300 adjacent to each other are combined each other and movement of the unit blocks due to waves may be prevented. The combining groove 360 may have a predetermined width and a predetermined length.

[00113] In addition, in the unit layer 410, arc shape incision portions 370 adjacent each other form a through hole 420. Seawater may flow in the unit layer 410 through the through hole 420 and flow out of upper portion or lower portion of the unit layer 410.

[00114] In addition, the unit blocks 300 of the unit layer 410 may be alternately arranged in a perpendicular direction in a same plane. For example, when the long side of the rectangular shape unit block 300 is twice of the short side, the long side of the rectangular shape unit block 300 may be located to make contact with two half of long sides of other rectangular shape unit blocks 300, contact with two short side of other rectangular shape unit blocks 300, contact with one short side of another rectangular shape unit block 300 and one side of square shape unit block 300, or contact with one short side of another rectangular shape unit block 300 and one half of long side of the other rectangular shape unit block 300.

In addition, at least one square shape unit block 300 may preferably be disposed adjacent to

a side of the rectangular shape unit block 300. It is preferred that three or more contacting faces of the unit blocks are not to be connected with each other in a straight line.

[00115] FIG. 5 is a front view illustrating a plurality of unit layers which are stacked according to the first embodiment.

5 **[00116]** Referring to FIG. 5, the block layer 400 of FIG. 1 may be formed by stacking a plurality of unit layers 410 in the vertical direction.

[00117] Here, each of the unit layers 410 are stacked to make the combining grooves 360 of a pair of unit blocks 300 adjacent each other in the vertical direction contact each other. The combining part 900 is inserted in the combining grooves 360, so that the pair of unit
10 blocks may be fixed.

[00118] The combining grooves 360 may have same size and shape such as same width, length and depth, so that same shape of the combining parts 900 may be used to fix the unit blocks in a same plane and in the vertical direction. In some example embodiment, the combining grooves 360 have different shape and size, so that the combining parts 900 which
15 have different size and shape may be used to fix the unit blocks in a same plane and in the vertical direction, respectively.

[00119] second embodiment

[00120] FIG. 6 is a plan view illustrating a unit layer according to a second embodiment of the invention. FIG. 7 is a front view illustrating a plurality of unit layers which are stacked
20 according to the second embodiment.

[00121] The second embodiment is similar to the first embodiment, except for a combining groove 360a and a combining part 900a. Thus, the same reference numerals will be used to refer to the same or like parts of the first embodiment. Any further detailed descriptions concerning the same elements will be omitted.

25 **[00122]** According to the second embodiment, the combining part 900a has a T-shape.

Thus, a pair of combining portion 910 having a bar shape and spaced apart from and in parallel with each other and a connecting portion 920 connecting middle of the combining portion 910 to middle of the other combining portion 910.

[00123] Here, the combining groove 360a also has a T-shape, so that the combining portion 910 and half of the connecting portion may be inserted into the combining groove 360a.

[00124] In the first embodiment, it is possible that a pair of unit blocks 300 adjacent each other is disassembled by a movement of the unit blocks 300 in a length direction of the combining part 900. However, in the second embodiment, the combining portion 910 is perpendicular to the length direction of the combining part 900a (perpendicular to the connecting portion 920), unwanted disassemble of the unit blocks 300 cause by the movement in the length direction of the combining part 900a may be prevented.

[00125] For example, in the block layer 400 of the first embodiment in FIG. 5, it is possible that the combining part 900 is disassembled when a wave moves the unit blocks 300 in a vertical direction. However, in the block layer of the second embodiment in FIG. 7, the combining portion 910 of the combining part 900a may firmly fix the adjacent unit blocks 300 although external force in the vertical direction is applied.

[00126] In addition, the combining groove 360a and the combining part 900a may also be applied to other embodiments which will be mentioned later.

[00127] third embodiment

[00128] FIG. 8 is a perspective view illustrating a rectangle unit block according to a third embodiment of the invention. FIG. 9 is a perspective view illustrating a square unit block according to the third embodiment.

[00129] The third embodiment is similar to the first and second embodiments, except that a unit block 300b is integrally formed, unlike the unit block of the above embodiment

including the upper plate, the lower plate and the middle plate.

[00130] Here, the unit block 300b has a hexahedron shape as illustrated in FIGS. 8 and 9.

An upper surface and a lower surface have rectangle or square shape like that of the upper, lower and middle plates of the above embodiment.

5 **[00131]** In addition, an insert hole 350, the combining groove 360 and incision portion 370 may be formed at same positions of the above embodiment with same shapes. The unit blocks 300b adjacent each other in a same plane or in vertical direction may be firmly fixed by combination of the combining part 900 to the combining groove 360

[00132] The unit blocks 300b of the third embodiment may be arranged on the block layer
10 400 at inland sea or offshore in a line. Here, the unit blocks 300 may be disposed in a lower portion of the stacked block layers 400, and the unit blocks 300a may be disposed in an upper portion of the stacked block layers 400, so that sea water may freely flow through lower portion of the stacked block layers 400 which includes the unit blocks 300 of the above embodiments, and wave may be blocked by the upper portion of the stacked block
15 layers 400 which includes the unit blocks 300b of the third embodiment.

[00133] forth embodiment

[00134] FIGS. 10 and 11 are perspective views illustrating a rectangle unit block according to a fourth embodiment of the invention. FIG. 12 is a perspective view illustrating a square unit block according to the fourth embodiment.

20 **[00135]** The unit block 300c of the fourth embodiment is similar to the unit block 300 of the first embodiment, except that a plurality of semi-cylinders 380 are formed on a surface of the unit block 300c. Thus, the same reference numerals will be used to refer to the same or like parts of the first embodiment. Any further detailed descriptions concerning the same elements will be omitted.

25 **[00136]** The unit block 300c of the fourth embodiment includes the semi-cylinder 380

formed from a side edge of the upper plate 310 to a side edge of the lower plate 320. A plurality of the semi-cylinders 380 spaced apart each other may be formed along a length direction of the unit block 300c.

[00137] The unit blocks 300c may be disposed in a line at the upper portion of the block layer 400 at inland sea side or offshore side, so that the semi-cylinders 380 may reduce wave. In addition, it may help berthing of vessels.

[00138] fifth embodiment

[00139] FIGS. 13 and 14 are perspective views illustrating a rectangle unit block according to a fifth embodiment of the invention. FIG. 15 is an exploded perspective view illustrating a breakwater structure which is constructed using the rectangle unit blocks according to the fifth embodiment.

[00140] The unit block 300d of the fifth embodiment is similar to the unit block 300c of the fourth embodiment, except that a blocking wall 390 is formed opposite to a semi-cylinder 380. Thus, the same reference numerals will be used to refer to the same or like parts of the fourth embodiment. Any further detailed descriptions concerning the same elements will be omitted.

[00141] The unit block 300d of the fifth embodiment has the blocking wall 390 opposite to the semi-cylinders 380. The blocking wall 390 is formed along edge of the upper plate 310 and the lower plate 320. The unit block 300d may be disposed in a line at the upper portion of the block layer 400 at inland sea side or offshore side the block layer 400. According to the breakwater structure including the unit blocks 300d, energy of wave may be effectively reduced by the breakwater structure and it may help berthing of vessels.

[00142] In addition, although only rectangle shape unit block 300d is described, the upper plate 310, the lower plate 320 and the middle plate 330 may have square shape like the above embodiments. In addition, although an incision portion 370 is not formed in the

embodiment of FIGS 13 and 14, an arc shape incision portion may be formed at a vertex or at a long side if necessary like the above embodiment.

[00143] sixth embodiment

[00144] FIG. 16 is a perspective view illustrating a rectangle unit block according to a sixth embodiment of the invention. FIG. 17 is a perspective view illustrating a square unit block according to the sixth embodiment.

[00145] The unit block 300e of the sixth embodiment is similar to the unit block 300d of the fifth embodiment, except that a blocking wall 390 is formed along an edge which is perpendicular to an edge at which a semi-cylinder 380 is formed. Thus, the same reference numerals will be used to refer to the same or like parts of the fifth embodiment. Any further detailed descriptions concerning the same elements will be omitted.

[00146] The unit block 300e of the sixth embodiment, the blocking wall 390 is formed at a side surface which is perpendicular to a surface on which a plurality of the semi-cylinders 380 are formed.

[00147] For example, in the unit block 300e of FIG. 16, the blocking wall 390 is formed along a short side. Here, when the short side of the unit block 300e having square shape is located toward inland or offshore, the short side of the unit block 300e may block the wave to reduce its energy. Accordingly, construction of the breakwater is easy. Here, the blocking wall 390 may be also formed at a surface which is opposite to a surface on which the semi-cylinder 380 is formed, like the fifth embodiment.

[00148] seventh embodiment

[00149] FIG. 18 is a perspective view illustrating a rectangle unit block according to a seventh embodiment of the invention. FIG. 19 is a perspective view illustrating a square unit block according to the seventh embodiment.

[00150] The unit block 300f of the seventh embodiment is similar to the unit block 300e of

the fifth embodiment, except that a blocking wall 390 is formed between the upper plate 310 and the middle plate 330, and a space between the middle plate 330 and the lower plate 320 is opened. Thus, the same reference numerals will be used to refer to the same or like parts of the fifth embodiment. Any further detailed descriptions concerning the same elements will be omitted.

[00151] In the unit block 300f, the blocking wall 390 is formed on a surface opposite to a surface on which the semi-cylinder 380 is formed. The blocking wall 390 extends from the upper plate 310 to the middle plate 330. Thus, an upper space of the unit block 300f is closed by the blocking wall 390, a lower space from the middle plate 330 to the lower plate 320 is opened.

[00152] If there is need to control shape and height of the blocking wall 390 according to wave and environment condition of emplacement of the breakwater structure, the breakwater structure may be constructed using the unit block 300f of the seventh embodiment.

[00153] eight embodiment

[00154] FIG. 20 is a perspective view illustrating a rectangle unit block according to an eighth embodiment of the invention. FIG. 21 is a perspective view illustrating a square unit block according to the eighth embodiment.

[00155] The unit block 300g of the eighth embodiment is similar to the unit block 300f of the seventh embodiment, except that a blocking wall 390 is formed between the middle plate 330 and the lower plate 320, and a space between the upper plate 310 and the middle plate 330 is opened. Thus, the same reference numerals will be used to refer to the same or like parts of the fifth embodiment. Any further detailed descriptions concerning the same elements will be omitted.

[00156] If there is need to control shape and height of the blocking wall 390 according to wave and environment condition of emplacement of the breakwater structure, the breakwater

structure may be constructed using the unit block 300g of the eighth embodiment.

[00157] ninth embodiment

[00158] FIG. 22 is a perspective view illustrating a rectangle unit block according to a ninth embodiment of the invention.

5 **[00159]** According to the ninth embodiment, an insert hole 350h having hexagon shape is formed, so that when an insert bar 500 is inserted, rotating movement of the unit block 300h with respect to the insert hole 350h as a center of rotation or may be prevented. Here, the insert bar 500 also has the hexagon shape corresponding to the insert hole 350h.

[00160] Here, the unit block 300h of FIG. 22 has an appearance same as the first
10 embodiment, appearance of rectangle or square shape unit blocks 300 to 300g may also applied to the unit block 300h of ninth embodiment.

[00161] In addition, the breakwater structure may include each of unit blocks of the first to ninth embodiment alone or in combination.

[00162] tenth embodiment

15 **[00163]** FIG. 23 is an exploded perspective view illustrating a breakwater structure according to a tenth embodiment.

[00164] The breakwater structure 1000 according to the tenth embodiment includes a supporting plate 2000 which is constructed undersea and a block layer 3000 including a plurality of unit blocks which are stacked on the supporting plate 2000.

20 **[00165]** the supporting plate 2000 may be constructed undersea, and may be stacked on a foundation ground 2100. The supporting plate 2000 may be consist of one plate, or the supporting plate 2000 may include a plurality of blocks which are arranged in a plane to form a plate. The foundation ground 2100 may be formed by foundation work on seafloor, and may improve flatness of the seafloor. A seating groove 2110 is formed on an upper
25 surface of the foundation ground 2100 to fix the supporting plate 2000. A fixing jaw 2120

may be formed at both sides of the seating groove 2110 to prevent movement of supporting plate 2000.

[00166] The foundation ground 2100 may be constructed under the seafloor by a predetermined depth, or the foundation ground 2100 may be constructed by inserting fixing bar 2130 protruded from a bottom surface of the foundation ground 2100 into the seafloor.

[00167] The supporting plate 2000 may be integrally formed with the foundation ground 2100. However, constructing method of the supporting plate 2000 is not limited thereto, and various modifications may be possible. In addition, the supporting plate 2000 may be formed by a concrete. However, the material of the supporting plate 2000 is not limited thereto, and variety of materials may be used for forming the supporting plate 2000.

[00168] A plurality of unit blocks are stacked on the supporting plate 200 to form the block layer 3000. The block layer 3000 may block wave from offshore to reduce energy of the wave, and makes it possible that natural flow of sea water between offshore and inland sea. Here, the unit blocks which are arranged in a plane or stacked in a vertical direction may be firmly combined together by a combining part (refers to 7100, 7200 of FIGS. 41 and 42) which will be mentioned later, so that movement of the unit blocks by the wave or damage on the block layer 3000 may be prevented. The unit block may be formed by a concrete. However, the material of the unit block is not limited thereto, and variety of materials may be used for forming the unit block.

[00169] According to the present embodiment, the block layer 3000 includes three unit layers. Thus, the block layer 3000 includes a first block layer 3100 on the supporting plate 2000, a second block layer 3200 on the first block layer 3100 and third block layer 3300 on the second block layer 330. However, the number of unit layers and stacking order of the layers are not limited thereto, and various modifications may be possible. In addition, various type of unit blocks in each of the unit layers may be applied to each of the unit

layers, respectively.

[00170] Thus, according to the tenth embodiment, at least one of the first block layer 3100, the second block layer 3200 and the third block layer 3300 may be continuously stacked in the vertical direction to form some or all of the block layer 300. The first block layer 3100, the second block layer 3200 and the third block layer 3300 may be sequentially stacked to form some or all of the block layer 300. In addition, although the first block layer 3100, the second block layer 3200 and the third block layer 3300 are sequentially stacked in the present embodiment, the layers may be stacked in a different order. In addition, another unit layer may be formed by using at least two of the unit block of the first block layer 3100, the unit block of the second block layer 3200 and the unit block of the third block layer 3300.

[00171] In addition, to improve fixation of the block layer 300, an insert bar 4000 through the block layer 300 in the vertical direction may be combined. Here, an insert groove 2010 may be preferably formed on the upper surface of the supporting plate 2000 configured to receive a lower portion of the insert bar 4000.

[00172] A cover plate 5000 may be seated on the block layer 4000. The cover plate 5000 may prevent flow out of sea water from the breakwater structure 1000, and may provide sidewalk or road to pass through.

[00173] Here, the cover plate 5000 may be formed by a concrete. However, the material of the cover plate 5000 is not limited thereto, and variety of materials may be used for forming the cover plate 5000. For example, the cover plate 5000 may be a transparent acrylic plate having a predetermined thickness. Accordingly, flow of sea water through the breakwater structure 1000 may be visible.

[00174] Hereinafter, referring to FIGS. 24 to 40, unit layer stacked on the supporting plate 2000, and an unit block which composes the supporting plate 2000 will be described in

detail.

[00175] FIG. 24 is a perspective view illustrating a first block layer of the breakwater structure according to the tenth embodiment. FIGS. 25 and 26 are perspective views illustrating a rectangle unit block of the first block layer according to the tenth embodiment. FIGS. 27 and 28 are perspective views illustrating a square unit block of the first block layer according to the tenth embodiment.

[00176] Each of the unit blocks 6010 and 6020 of the first block layer 3100 according to the tenth embodiment includes an upper plate 6100, a lower plate 6200 and at least one supporting part 6300 disposed on the lower plate 6200 to support the upper plate 6100. The upper plate 6100 has a shape substantially same as the lower plate 6200, and is spaced apart from the lower plate 6200 in a vertical direction by the supporting part 6300 which has a column shape. Here, that the upper plate 6100 and the lower plate 6200 have same shape means that each of width and length is same, so that thickness of the upper plate 6100 and thickness of the lower plate 6200 may be same or different each other.

[00177] A combining groove 6400 for combination of a combining part 7100 and 7200 is formed on the upper plate 6100. A locking portion 6500 is formed on a bottom surface of the combining groove 6400. The combining groove 6400 include at least one first combining groove 6410 formed along an edge of the upper plate 6100, and a second combining groove 6420 formed at a center of the upper plate 6100. The locking portion 6500 includes a first locking portion 6510 at the first combining groove 6410, and a second locking portion 6520 at the second combining groove 6420.

[00178] The unit block of the first block layer 3100 of the tenth embodiment, a first unit block 6010 having rectangular shape illustrated in FIGS. 25 and 26, and a second unit block 6020 having square shape illustrated in FIGS. 27 and 28.

[00179] Referring to FIGS, 25 and 26, each of the upper plate 6100 and the lower plate

6200 of the first unit block 6010 have rectangular shape having a long side and a short side. The long side is n-times longer than short side (here, n is 2 or natural number greater than 2).

[00180] Here, a first combining groove 6410 is formed at $(2k-1)/2n$ point of the long side (here k is an integer that increases by 1 from 1 to n) and 1/2 point of the short side of the upper plate 6100. Here, the first combining groove 6410 has a pair of first groove portions 6410a which are spaced apart from and in parallel with each other and a second groove portion 6410c connecting the two first groove portions 6410a, so that first combining groove 6410 has overall C-shape. In some example embodiment, the first combining groove 6410 may have U-shape or arc shape.

[00181] The second combining groove 6420 having quadrangle shape is formed in the middle of the upper plate 6100. In some example embodiment, the second combining groove 6420 may have oval or circle shape. Here, when two unit blocks are disposed adjacent each other, two first combining grooves 6410 which are symmetrical to each other may preferably form a shape of the second combining groove 6420. For example, two first combining grooves 6410 having C-shape may make contact to each other, so that the combining grooves 6410 may form quadrangle shape. Two first combining grooves 6410 having U-shape may make contact to each other to form rectangular oval. Two first combining grooves 6410 having arc shape may make contact to each other to form oval or circle. In addition, width, length and depth of the first and second combining groove 6410 and 6420 may be properly designed as required.

[00182] The first locking portion 6510 having a rectangular shape is formed from a bottom surface of the first combining groove 6410 to an upper surface of the upper plate 6100 at the first combining groove 6410. The second locking portion 6520 having a rectangular shape is formed from a bottom surface of the second combining groove 6420 to an upper surface of the upper plate 6100 at the second combining groove 6420. Here, when two unit blocks

are disposed adjacent each other, two first locking portions 6510 which are symmetrical to each other may preferably form a shape of the second locking portion 6520. The first and locking portions 6510 and 6520 may have arc, oval or circle shape according to the first and second combining grooves 6410 and 6420.

5 **[00183]** In addition, an insert groove 6210 having a predetermined width and length and extending perpendicular to an edge of the lower plate 6200 is formed along the edge of the lower plate 6200. The insert groove 6210 is formed corresponding to the first groove portion 6410a of the first combining groove 6410 in the vertical direction.

[00184] In addition, for circulation of the sea water in the vertical direction through the
10 first block layer 3100, at least one arc shape incision portion 6600 is formed at an edge of the upper plate 6100 and the lower plate 6200. For example, as described in FIGS. 25 and 26, when the long side is twice of the short side of the first unit block 6010, the arc shape incision portion 6600 may be formed at least one point among vertexes of corners and 1/2 point of the long side as a center of the arc shape.

15 **[00185]** In addition, at least one insert hole 6700 through the vertical direction is formed at the upper plate 6100 and the lower plate 6200. Seawater may flow through the insert hole 6700, or the insert bar 4000 for preventing movement of the unit blocks stacked in vertical direction may be inserted into the insert hole 6700 if necessary.

[00186] Here, the insert bar 4000 may be inserted into each of the insert holes 6700, or the
20 insert bar 4000 may be inserted into at least one insert hole 6700 which is selected if necessary. In addition, the insert bar 4000 may be inserted from the insert hole 6700 of the unit block which locates on top layer to the insert groove 2010 of the supporting plate 2000. In addition, the insert bar 4000 may be inserted through insert holes 6700 of at least two unit blocks.

25 **[00187]** In addition, although the supporting part 6300 is spaced apart from the insert

holes 6700 in the present embodiment, the supporting part 6300 and the insert holes 6700 may be formed at a same position according to some example embodiment. In this case, the supporting part 6300 has larger diameter than that of the insert holes 6700, and a hole (not shown) for inserting the insert bar 4000 therethrough and connected to the insert holes 6700 is formed at the middle of the supporting part 6300 in a length direction.

[00188] Referring to FIGS. 27 and 28, a first combining groove 6410 and a first locking portion 6510 are formed along an edge of the upper plate 6100 of the second unit block 6020 like the first unit block 610. An insert groove 6210 is formed along an edge of the lower plate 6200 of the second unit block 6020. At least one supporting part 6300 is formed on the lower plate 6200 to support the upper plate 6100.

[00189] The second unit block 6020 is different from the first unit block 6010 in that each sides of the second unit block 6020 is same, and the second combining groove 6420 is not formed on the upper plate 6100 of the second unit block 6020. Here, each of the side of the second unit block 6020 may preferably have length same as the short side of the first unit block 6010.

[00190] In the second unit block 6020, a first combining groove 6410 is formed at 1/2 point of each of sides. Size and shape of the first combining groove 6410 is same as that of the first combining groove 6410 of the first unit block 6010. Similarly, an arc shape incision portion 6600 is formed at a vertex of a corner, and an insert hole 6700 may be formed at the middle of the upper plate 6100 and the lower plate 6200.

[00191] Referring again to FIG. 24, the first block layer 3100 of the tenth embodiment include a plurality of the first unit blocks 6010 and/or the second unit blocks 6020 arranged in a same plane. A plurality of the first blocks layers 3100 are stacked in the vertical direction to form a portion of the block layer 3000.

[00192] The first and second unit blocks 6010 and 6020 of the first block layer 3100 are

arranged in a same plane, and the first combining grooves 6410 of each of the first and second unit blocks 6010 and 6020 make contact with and symmetrical to each other. Here, the combining part 7100, 7200 is inserted into the first combining grooves 6410, so that adjacent first and second unit blocks may be firmly fixed. Elements and combining of the combining part 7100, 7200 will be described in detail in FIG. 41 and 43.

[00193] The arc shape incision portions 6600 of the first and second unit blocks 6010 and 6020 which are disposed adjacent each other may form a circle shape through hole 6610. Seawater flows into the first block layer 3100 through the through hole 6610 and flows out upward or downward of first block layer 3100.

[00194] In addition, the first and second unit blocks 6010 and 6020 of the first block layer 3100 may be alternately arranged in a perpendicular direction in a same plane. For example, when the long side of the first unit block 6010 is twice of the short side, the long side of the first unit block 6010 may be located to make contact with two half of long sides of other first unit block 6010, contact with two short side of other first unit block 6010, contact with one short side of another first unit block 6010 and one side of the first unit block 6020, or contact with one short side of another the first unit block 6010 and one half of long side of the other first unit block 6010. In addition, at least one second unit block 6020 may preferably be disposed adjacent to a side of the first unit block 6010. It is preferred that three of more contacting faces of the first and second unit blocks are not to be connected with each other in a straight line.

[00195] FIG. 29 is a perspective view illustrating a second block layer of the breakwater structure according to the tenth embodiment. FIGS. 30 and 31 are perspective views illustrating a rectangle unit block of the second block layer according to the tenth embodiment. FIGS. 32 and 33 are perspective views illustrating a square unit block of the second block layer according to the tenth embodiment.

[00196] Third and fourth unit blocks 6030 and 6040 of the second block layer 3200 are similar to the first and second unit blocks 6010 and 6020 of the first block layer 3100, except for a middle plate 6150 formed between the upper plate 6100 and the lower plate 6200. Thus, the same reference numerals will be used to refer to the same or like parts of the first
5 embodiment. Any further detailed descriptions concerning the same elements will be omitted.

[00197] The middle plate 6150 may have size and shape substantially same as those of the upper plate 6100 and the lower plate 6200. The middle plate 6150 is formed between the upper plate 6100 and the lower plate 6200 in parallel with the upper and lower plates 6200
10 and 6100, and is supported by the supporting part 6300. Here, thickness of the middle plate 6150 may be same or different from that of the upper plate 6100 or the lower plate 6200. The insert hole 6700 and the incision portion 6600 may be formed corresponding to the upper plate 6100 and the lower plate 6200.

[00198] FIG. 34 is a perspective view illustrating a third block layer of the breakwater
15 structure according to the tenth embodiment. FIGS. 35 and 36 are perspective views illustrating a rectangle unit block of the third block layer according to the tenth embodiment.

[00199] Referring to FIGS. 35 and 36, a fifth unit block 6050 of the third block layer 3300 having a rectangular shape includes the upper plate 6100, the lower plate 6200 and the middle plate 6150. At least one supporting part 6300 having cylindrical column shape is
20 formed between the upper plate 6100 and the lower plate 6200 through the middle plate 6150.

[00200] In addition, semi-cylinder 6800 is formed from a side edge of the upper plate 610 to a side edge of the lower plate 6200. A plurality of the semi-cylinders 6800 spaced apart each other may be formed along a length direction of the fifth unit block 6050. A blocking
25 wall 6900 having a plate shape may be formed on a surface opposite to a surface on which

the semi-cylinders 6800 is formed.

[00201] First combining grooves 6410 are formed along the edge of the upper plate 6410 except for where the semi-cylinders 6800 is formed. A first locking portion 6510 is protruded from a bottom surface of the first combining groove 6410. A second combining groove 6420 and a second locking portion 6520 are formed at a center of the upper plate 6100. Insert holes 6700 are formed at both sides of the second combining groove 6420.

[00202] Insert grooves 6210 corresponding to the first combining grooves 6410 are formed at both ends of the lower plate 6200 in a length direction. A locking groove 6910 corresponding to an insert portion 7120 of the first combining part 7100 which will be mentioned later is formed at a lower portion of the blocking wall 6900.

[00203] FIGS. 37 and 38 are perspective views illustrating another example of a rectangle unit block of the third block layer according to the tenth embodiment.

[00204] A sixth unit block 6060 of FIGS. 37 and 38 includes the upper plate 6100, the lower plate 6200 and the middle plate 6150. At least one supporting part 6300 having cylindrical column shape is formed between the upper plate 6100 and the lower plate 6200 through the middle plate 6150.

[00205] In addition, a plurality of semi-cylinders 6800 are formed on a surface in a length direction of the sixth unit block 6060. The first combining groove 6410 and the insert groove 6210 are formed along edges of the upper and lower plates 6100, 6200 except for an edge where the semi-cylinders 6800 is formed. The first locking portion 6510 is protruded from the first combining groove 6410. The second combining groove 6420 and the second locking portion 6520 are formed at a center of the upper plate 6100. The insert holes 6700 are formed at both sides of the second combining groove 6420.

[00206] The blocking wall 6900 is formed from a middle of the upper plate 6100 in a length direction to lower plate 6200 in a perpendicular direction. The arc shape incision

portions 6600 are formed at both vertexes of a corner of a surface opposite to the blocking wall 6900 and a side of the blocking wall 6900 and at the upper plate 6100, the lower plate 6200 and the middle plate 6150, respectively. The arc shape incision portion 6600 of the upper plate 6100, the lower plate 6200 and the middle plate 6150 are corresponding to each other.

[00207] FIGS. 39 and 40 are perspective views illustrating a square unit block of the third block layer according to the tenth embodiment.

[00208] The seventh unit block 6070 of FIGS. 39 and 40 is same as half of the fifth unit block 6050 of FIGS 35 and 36 in a length direction. Thus, any further detailed descriptions concerning the same elements will be omitted.

[00209] Referring to FIGS. 35 to 40, the unit blocks 6050 to 6070 may reduce the wave by the semi-cylinder 6800 or the blocking wall 6900. In addition, it may help berthing of vessels.

[00210] Thus, the unit blocks 6050 to 6070 which include the semi-cylinder 6800 and the blocking wall 6900 may preferably be disposed that the semi-cylinder 6800 faces inland sea side or offshore side at an upper portion of the block layer 3000 in a line, like FIGS. 23 and 34. In the embodiment of FIG. 34, the unit blocks 6050 to 6070, and the third and fourth unit blocks 6030 and 6040 of the second block layer 3200 are combined together in a same plane to form the third block layer 3300. Here, the first and second unit blocks 6010 and 6020 of the first block layer 3100 may be applied instead of the third and fourth unit blocks 6030 and 6040 of the second block layer 3200.

[00211] FIG. 41 is a perspective view illustrating a first combining part according to the tenth embodiment.

[00212] The first combining part 7100 may combine a pair of unit blocks stacked in the vertical direction, so that movement or slip of the unit blocks by the wave may be prevented.

[00213] The first combining part 7100 include a seating portion 7110 which is inserted into the first combining groove 6410 or the second combining groove 6420 and an insert portion 7120 which is inserted into the insert groove 6210 or the locking groove 6910. Each of the seating portion 7110 and the insert portion 7120 has C-shape. The insert portion 7120 is perpendicularly bent from a side of the seating portion 7110.

[00214] Here, the seating portion 7110 includes a pair of supporting bars 7110a spaced apart from and in parallel with each other, and a first connecting bar 7110b connecting ends of the supporting bars 7110a. The insert portion 7120 includes a pair of vertical bars 7120a extending vertically upward from another end of the supporting bar 7110a, and a second connecting bar 7120b connecting upper ends of the vertical bars 7120a.

[00215] When the first combining part 7100 is inserted into the combining groove 6400, the first combining part 7100 inserted in the first combining groove 6410 or the second combining groove 6420 of a unit block of a lower layer may be supported by the first locking portion 6510 or the second locking portion 6520. In addition, the vertical bar 7120a of the insert portion 7120 is inserted in the insert groove 6210 of a unit block of upper layer, so that the second connecting bar 7120b of the insert portion 7120 may be supported by the lower plate 6200 of the unit block of the upper layer, or may be supported by the locking groove 6910 of the unit block of the upper layer. Accordingly, movement between the unit block of the upper layer and the unit block of the lower layer may be prevented, and movement between the unit blocks in a same plane may be prevented.

[00216] In addition, the seating portion 7110 may have U-shape or arc shape corresponding to the first or second combining groove 6410 or 6420 according to another embodiment.

[00217] FIG. 42 is a perspective view illustrating a second combining part according to the tenth embodiment.

[00218] The second combining part 7200 may combine a pair of unit blocks adjacent to each other in a same plane, so that movement or slip of the unit blocks of an unit layer by the wave may be prevented.

[00219] The second combining part 7200 may have quadrangle ring shape. When the second combining part 7200 is inserted in a pair of the first combining grooves 6410 which make contact with each other, the second combining part 7200 may be fixed by a pair of the first locking portion 6510.

[00220] In addition, the second combining part 7200 may have a rectangular oval shape, oval shape and circular ring shape to be corresponding to the first combining grooves 6410 of another example embodiment.

[00221] FIG. 43 is perspective view illustrating use of the first and second combining parts according to the tenth embodiment.

[00222] The first combining part 7100 of the tenth embodiment may combine a pair of unit blocks stacked in the vertical direction.

[00223] For example, when the second block layer 3200 is stacked on the first block layer 3100, the third or fourth unit block 6030 or 6040 of the second block layer 3200 is stacked on the first or second unit block 6010 or 6020 of the first block layer 3100, and then the first combining part 7100 is inserted, so that the unit blocks 6010 to 6040 in the vertical direction may be combined each other.

[00224] More specifically, the seating portion 7110 of the first combining part 7100 is inserted into the first or second combining groove 6410 or 6420 of the upper plate 6100 of the first or second unit block 6010 or 6020. Here, a pair of vertical bars 7120a of the insert portion 7120 of the first combining part 7100 is inserted into the insert groove 6210 of the lower plate 6200 of the third or fourth unit block 6030 or 6040. The second connecting bar 7120b is supported by the lower plate 6200 of the third or fourth unit block 6030, 6040.

Accordingly, movement or slip of the first or second unit block 6010, 6020 and the third or fourth unit blocks 6030, 6040 which are stacked in the vertical direction by the wave may be prevented. In addition, when the third block layer 3300 is stacked on the second block layer 3200, the insert portion 7120 of the first combining part 7100 may be inserted in the locking groove 6910 at a lower portion of the blocking wall 6900 of the fifth or seventh unit block 6050 or 6070. In addition, a side of the seating portion 7110 (where the first connecting bar 7110b is formed) and another side of the seating portion 7110 (where the vertical bar 7120a is formed) are disposed in a pair of the first combining grooves 6410 which are adjacent to each other, the first combining part 7100 may prevent movement of the pair of the unit blocks in a same plane adjacent to each other.

[00225] The second combining part 7200 of the tenth embodiment may combine a pair of the unit blocks in a same plane adjacent to each other. Here, the second combining part 7200 is inserted in a pair of the first combining grooves 6410 which make contact with each other. The second combining part 7200 may be fixed by a pair of the first locking portion 6510, so that movement of the unit blocks may be prevented.

[00226] In addition, the first combining part 7100 and the second combining part 7200 may be properly selected and applied to the first combining grooves 6410 or the second combining grooves 6420. There is no need that the combining part 7100, 7200 are combined to all combining grooves 6400.

[00227] According to the combining parts 7100 and 7200 of the tenth embodiment, the unit blocks in a horizontal direction and in the vertical direction may be firmly fixed without the insert bar 4000 inserted in the insert hole 6700. Thus, movement of or damage on the block layer 300 by an external force may be prevented. In addition, construction of the breakwater structure is conducted by arrangement of unit blocks and combining of the combining parts 7100 or 7200, so that construction is easy. Although the combining parts

7100 or 7200 is destroyed by a shearing force, these may be replaced with low cost.

[00228] The foregoing is illustrative of the invention and is not to be construed as limiting thereof. Although a few exemplary embodiments of the invention have been described, those skilled in the art will readily appreciate that many modifications are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of the invention. Accordingly, all such modifications are intended to be included within the scope of the invention as defined in the claims. In the claims, means-plus-function clauses are intended to cover the structures described herein as performing the recited function and not only structural equivalents but also equivalent structures. Therefore, it is to be understood that the foregoing is illustrative of the invention and is not to be construed as limited to the specific exemplary embodiments disclosed, and that modifications to the disclosed exemplary embodiments, as well as other exemplary embodiments, are intended to be included within the scope of the appended claims. The invention is defined by the following claims, with equivalents of the claims to be included therein.

[Reference Numerals]

[00229] 100,1000 : breakwater structure 200,2000 : supporting plate

[00230] 300~300h,6010~6070 : unit block

[00231] 310,6100 : upper plate 320,6200 : lower plate

[00232] 330,6150 : middle plate 340,6300 : supporting part

[00233] 350,350h,6700 : insert hole 360,360a,6400 : combining groove

[00234] 370,6600 : incision portion 380,6800 : semi-cylinder

[00235] 390,6900 : blocking wall 400,3000 : block layer

[00236] 410,3100~3300 : unit layer 420,6610 : through hole

[00237] 500,4000 : insert bar 600,2100 : foundation ground

[00238] 800,5000 : cover plate

900,900a,7100,7200 : combining

part

【CLAIMS】

1. A breakwater structure, comprising:

a supporting plate which is constructed undersea;

a block layer comprising a plurality of unit blocks which are stacked on the
5 supporting plate; and

an insert bar combined through the block layer in a vertical direction,

wherein the unit block comprises:

upper and lower plates having rectangle or square shape and spaced apart
each other in the vertical direction;

10 a supporting part formed between the upper and lower plates, and having a
column shape which is perpendicular to the upper and lower plates;

an insert hole formed at each of the upper and lower plates in which the
insert bar is inserted, the insert holes of the upper and lower plates corresponding to each
other; and

15 a combining groove formed at each of edge of the upper and lower plates.

2. The breakwater structure of claim 1, wherein the long side is n-times longer
than short side (here, n is 2 or natural number greater than 2) when the upper and lower
plates have rectangle shape,

20 the combining groove is formed at each of $(2k-1)/2n$ point of the long side (here k is
an integer that increases by 1 from 1 to n) and $1/2$ point of the short side of each of the upper
and lower plates.

3. The breakwater structure of claim 2, wherein when the long side is twice of
25 the short side, an arc shaped incision portion is formed at a vertex of a corner of the upper

and lower plates or 1/2 point of the long side as a center or the arc shape.

4. The breakwater structure of claim 1, wherein when each of the upper plate and the lower plate has square shape, the combining groove is formed at 1/2 point of each of
5 sides of the square shape.

5. The breakwater structure of claim 4, wherein an arc shaped incision portion is formed at a vertex of a corner of the upper and lower plate.

10 6. The breakwater structure of claim 1, wherein the a plurality of the unit blocks are arranged in a same plane to form a unit layer, the combining grooves of the unit blocks adjacent to each other make contact with each other, a plurality of unit layers are stacked in the vertical direction to form the block layer.

15 7. The breakwater structure of claim 6, further comprises a combining part inserted into the combining groove to combine a pair of the unit blocks adjacent each other.

8. The breakwater structure of claim 7, wherein the combining part comprises a pair of combining portions having a bar shape, spaced apart from and in parallel with each
20 other, and a connecting portion which connects middle of the combining portions each other.

9. The breakwater structure of claim 1, wherein a plurality of the unit blocks are alternately arranged in a perpendicular direction in a same plane,

when the long side of the rectangular shape unit block is twice of the short side, the
25 long side of the rectangular shape unit block is located to make contact with two half of long

sides of another rectangular shape unit blocks, or contact with two short side of another rectangular shape unit blocks, contact with one short side of another rectangular shape unit block and one side of square shape unit block, or contact with one short side of another rectangular shape unit block and a side of square shape unit block.

5

10. The breakwater structure of claim 1, wherein the unit block further comprises a middle plate which is disposed between the upper plate and the lower plate in parallel with the upper and the lower plates and supported by the supporting part,

an insert hole in which the insert bar is inserted is formed at a side of the middle

10 plate,

at least one combining groove is formed along an edge thereof.

11. The breakwater structure of claim 1, wherein the unit block further comprises a plurality of semi-cylinders protruded from an edge of the upper plate to an edge of the lower plate, the semi-cylinders are formed along a length direction and spaced apart from each other.

15

12. The breakwater structure of claim 11, wherein the unit block further comprises a blocking wall formed along edges of the upper and lower plate which is opposite to the semi-cylinders

20

13. The breakwater structure of claim 11, wherein the unit block further comprises a blocking wall formed on a surface which is perpendicular to the edge on which the semi-cylinders are formed.

25

14. The breakwater structure of claim 1, wherein the supporting part extends from the insert hole of the upper plate to the insert hole of the lower plate,

the insert hole is formed through the supporting part in a length direction of the supporting part.

5

15. The breakwater structure of claim 1, wherein the unit block further comprises a middle plate, a plurality of semi-cylinders and a blocking wall,

the middle plate is disposed between the upper plate and the lower plate in parallel with the upper and the lower plates,

10 each of the semi-cylinders is protruded from an edge of the upper plate to an edge of the lower plate, the semi-cylinders are formed along a length direction and spaced apart from each other, and

the blocking wall is formed along edges of the upper and middle plates which are opposite to the semi-cylinders.

15

16. The breakwater structure of claim 1, wherein the unit block further comprises a middle plate, a plurality of semi-cylinders and a blocking wall,

the middle plate is disposed between the upper plate and the lower plate in parallel with the upper and the lower plates,

20 each of the semi-cylinders is protruded from an edge of the upper plate to an edge of the lower plate, the semi-cylinders are formed along a length direction and spaced apart from each other, and

the blocking wall is formed along edges of the middle and lower plates which are opposite to the semi-cylinders

25

17. The breakwater structure of claim 1, wherein the insert hole has a polygonal shaped cross-section.

18. A breakwater structure, comprising:
5 a supporting plate which is constructed undersea; and
a block layer comprising a plurality of unit blocks which are stacked on the supporting plate,
wherein the unit block comprises:

upper and lower plates spaced apart each other in the vertical direction;
10 a supporting part formed between the upper and lower plates, and having a column shape which is perpendicular to the upper and lower plates;
a combining groove formed on a upper plate; and
a locking portion protruded upward from a bottom surface of the combining groove.

15 19. The breakwater structure of claim 18, wherein the combining groove comprises a first combining groove formed along an edge of the upper plate.

20. The breakwater structure of claim 19, wherein the combining groove further
20 comprises a second combining groove formed at middle of the upper plate.

21. The breakwater structure of claim 19, further comprising a insert groove formed along an edge of the lower plate corresponding to the first combining groove.

25 22. The breakwater structure of claim 18, further comprising a combining part

inserted in the combining groove configured to combine a pair of the unit blocks which are disposed adjacent to each other.

23. The breakwater structure of claim 22, wherein the combining part
5 comprises a first combining part which combines a pair of the unit blocks which are stacked in the vertical direction, and a second combining part which combines a pair of the unit blocks which are disposed adjacent to each other in a same plane.

24. The breakwater structure of claim 23, wherein the first combining part
10 comprises:

a seating portion inserted into the combining groove, and configured to be locked by the locking portion; and

an insert portion protruded from the seating portion, inserted into the inserting groove of the unit block at a upper layer, and supported by lower plate of the unit block at
15 the upper layer

25. The breakwater structure of claim 24, wherein the seating portion has C-shape, U-shape or arc shape, and

both ends of the insert portion are vertically extended from both ends of the seating
20 portion.

26. The breakwater structure of claim 23, wherein the second combining part has quadrangle shape, oval shape or circular ring shape.

27. The breakwater structure of claim 18, wherein the unit block further

comprises a plurality of semi-cylinders protruded from an edge of the upper plate to an edge of the lower plate, the semi-cylinders are formed along a length direction and spaced apart from each other.

5 28. The breakwater structure of claim 27, wherein the unit block further comprises a blocking wall opposite to the semi-cylinders,

 29. The breakwater structure of claim 28, further comprises a locking groove formed at a lower portion of the blocking wall.

10 30. A construction method of a breakwater structure, comprising:
 (a) forming a supporting plate under the seafloor;
 (b) forming a block layer by stacking unit layers each of which includes a plurality of unit blocks on the supporting plate in a same plane; and
15 (c) seating a cover plate to cover a top layer or the block layer;
 wherein in the (b), a pair of unit blocks adjacent to each other are combined by a combining part.

 31. The construction method of claim 30, wherein in the (b), a pair of unit
20 blocks which are stacked in a vertical direction are combined with each other by a first combining part, and
 a pair of unit blocks which are disposed adjacent to each other in a same plane are combined with each other by a second combining part.

25 32. The construction method of claim 30, wherein in the (b), the unit block

comprises:

upper and lower plates spaced apart each other in the vertical direction;

a supporting part formed between the upper and lower plates, and having a column shape which is perpendicular to the upper and lower plates;

5 a combining groove formed on a upper plate;

a locking portion protruded upward from a bottom surface of the combining groove;

and

an insert hole formed along an edge of the lower plate and formed through the lower plate in the vertical direction.

10

33. The construction method of claim 32, wherein in the (b), the combining part comprises:

a seating portion having C-shape, U-shape or arc shape; and

an insert portion protruded from both ends of the seating portion, upper portions of

15 the insert portion are connected to each other,

wherein the seating portion is inserted in the combining groove of the unit block at a lower layer configured to be locked by the locking portion, and

the insert portion is inserted in the combining groove of the unit block at an upper layer configured to be supported by the lower plate of the unit block at the upper layer.

20

34. The construction method of claim 32, wherein in the (b), the combining groove has C-shape, U-shape or arc shape along an edge of the upper plate, and

when the unit block are arranged in a horizontal direction, the combining part is inserted in a pair of combining grooves symmetrically disposed adjacent to each other with

25 being locked by the locking portion.