

【DESCRIPTION】**【Invention Title】**

INTERLOCKING CAISSON BREAKWATER, AND METHOD FOR
CONSTRUCTING SAME

【Technical Field】

The present invention relates to a caisson breakwater, and more particularly, to a caisson breakwater and a method of constructing the same using a lengthening effect by interlocking caissons which are box-type structures used in the civil engineering field.

【Background Art】

In general, a caisson is a box-type structure used in the civil engineering field and is used in a breakwater.

Fig. 1 is a schematic top view of a conventional caisson breakwater having caissons independently moving, and hereinafter, each of the caissons constituting the breakwater is referred to as a unit caisson.

Referring to Fig. 1, a conventional caisson breakwater 10 is configured such that unit caissons 100 are disposed in a line, and is commonly constructed by manufacturing the unit caissons 100 on the land, launching them to be refloated, and then sinking and disposing them in a desired place.

In such a conventional caisson breakwater 10, since the respective unit caissons 100 independently move, maximum wave power is applied to every unit caisson 100.

Thus, the conventional caisson breakwater 10 is designed such that each of the unit caissons 100 withstands maximum wave pressure since the respective unit caissons 100 independently move relative to their adjacent caissons.

However, the conventional caisson breakwater 10 has a problem in that when a freak wave having greater than design wave height approaches, the freak wave exceeds the design resistance of the caisson breakwater, thereby causing meandering damage.

Figs. 2 (A) and (B) are schematic views illustrating damage states of the conventional independent-type caisson breakwater 10, from which it can be seen that as the conventional caisson breakwater 10 has the unit caissons 100 each of which independently moves, the caisson breakwater 10 may be damaged when a freak wave having greater than

design wave height approaches.

Damage of the caisson breakwater 10 caused by the freak wave, for example, in Japan, occurred in a various regions such as the Toyama Harbor (February, 2008) as well as the Nagasaki Harbor (July, 1991), the Kobe Harbor (July, 1991), the Katatomari Harbor (September, 1991), the Hachinohe Harbor (July, 1991), and the Tounier Harbor (March, 2003).

In the meantime, Figs. 3a to 4b, which is to illustrate a damage example of the caisson breakwater 10, show a damage example of the Hitachi Harbor in Ibaraki-ken, Japan.

Referring to Figs. 3a and 3b, when a design wave approaches from the outside to the inside of a harbor, a breakwater has resistance within a design resistance range and thus there is nothing wrong with the breakwater. However, it can be seen that referring to Figs. 4a and 4b, when a freak wave having a wave height (for example, 9.94 m), which is greater than a design wave height (for example, 7.6 m), approaches, the wave power is increased in the outside of the harbor and a wave trough is generated in the inside of the harbor, thereby causing meandering damage in the unit caissons 100.

Thus, there is an urgent need for an economical design capable of increasing stability of a caisson breakwater by securing a safety margin for design external force even when a freak wave occurs in response to a change in global or local climate change.

In the meantime, a conventional caisson breakwater is configured by disposing unit caissons, each of which is a box-type structure, in a line. The breakwater is generally constructed by manufacturing the unit caissons on the land, launching them to be refloated, and then sinking and disposing them in a desired place.

When a wave surges, incident and reflected waves occur in a breakwater. According to a wave incident angle, a stem wave along a lengthwise direction of the breakwater may occur.

Referring to Fig. 11, while a stem wave does not occur when an angle α between a breakwater and an incident wave is equal to or greater than 45 degrees (see Figs. 11 (A) and (B)), a stem wave occurs along with a reflected wave when the angle α between the breakwater and the incident wave is less than 45 degrees (see Fig. 11 (C)). Particularly,

when the angle α between the breakwater and the incident wave is less than 20 degrees, only a stem wave is generated (see Fig. 11 (D)).

Such a stem wave is amplified along the breakwater to gradually increase in wave height, and the amplified wave makes it difficult for a ship at a sea area to sail when its sea route is positioned at the end of the breakwater. If the amplified wave enters the harbor, it has an adverse influence on a ship 2 on the berth or harbor facilities.

Thus, it is very important to enable a stem wave to be controlled when a breakwater is constructed.

Figs. 12 and 13 are plan views of a design example illustrating a process of selecting a normal line of a breakwater when the conventional breakwater is designed. Referring to a design plan of constructing a breakwater of Fig. 12, it is preferable that a breakwater (dotted box in the figure) be arranged perpendicular to a direction of a main incident wave in order not to generate the aforementioned stem wave so that a transverse wave has no influence on the ship 2 in and out of harbor.

However, when it is extremely disadvantageous in an economical standpoint such as construction cost to construct a breakwater to be arranged perpendicular to a direction of a main incident wave since the water at the constructed place of the breakwater is too deep, the breakwater is lengthened for calm, or the like, there is no alternative but to design and construct the breakwater to be inclined with respect to the direction of a main incident wave as shown in Fig. 13.

When the breakwater is designed and constructed as described above, although there is an advantage in an economical standpoint, the generation of a stem wave and a reflected wave as described above, as a transverse wave, has an influence on the ship 2 in and out of harbor to work against safe navigation of the ship 2, such as sea route deviation.

In the meantime, if a breakwater is constructed perpendicular to the direction of a main incident wave due to the geographical nature of the sea area in which the breakwater is constructed, a harbor entrance may be widened and the water may be deep. If the harbor entrance is widened, a harbor utilization rate is reduced, and if the water is deep, a construction cost may be increased. Thus, in such cases, the construction direction of the breakwater is designed such that the harbor entrance may be narrowed and the water is not

deep. Here, the construction direction of the breakwater may be a direction in which a stem wave is generated.

Therefore, there is an urgent need for a development of a breakwater, which can narrow a harbor entrance to increase a harbor utilization rate, be economically designed, for example, by constructing the breakwater in shallow waters to reduce a construction cost, and cause a stem wave not to be generated.

【Disclosure】

【Technical Problem】

The present invention is conceived to solve the aforementioned problems in the prior art. Contrary to a conventional independent moving-type caisson breakwater, in a caisson breakwater according to the present invention, unit caissons constituting the breakwater are geometrically engaged and interlocked to each other to integrally move, so that wave power applied to each unit caisson is reduced by a smoothing effect of wave power through the lengthening of the caissons. Thus, an object of the present invention is to provide an interlocking caisson breakwater, which can be economically designed and have increased stability when a freak wave or the like approaches, and a method of constructing the interlocking caisson breakwater.

Also, in a caisson breakwater according to the present invention, unit caissons are interlocked to integrally move, thereby having high stability and being improved to prevent a stem wave from being generated although not arranged perpendicular to a direction of a main incident wave. Therefore, another object of the present invention is to provide an interlocking caisson breakwater for preventing a stem wave from being generated, which makes it possible to be economically designed and constructed in a sea area where the water is relatively deep to increase a construction cost or a harbor entrance is widened to reduce a harbor utilization rate by invasion waves when the breakwater is arranged perpendicular to a direction of an incident wave, secures stability in navigation of a ship by not generating a transverse wave at a sea route in a harbor entrance through prevention of a stem wave, and increases a harbor utilization rate by essentially blocking a stem wave invading an inside of a harbor; and a method of constructing the interlocking caisson breakwater.

【Technical Solution】

According to an aspect of the present invention for achieving the objects, there is provided a caisson breakwater having unit caissons disposed in a line, wherein the unit caissons are interlocked to integrally move by geometrically engaging lateral parts of the unit caissons, thereby reducing wave power per unit width that is applied to the caisson breakwater.

According to an aspect of the present invention for achieving the objects, there is provided a caisson breakwater having unit caissons disposed in a line, wherein the unit caissons are interlocked to integrally move by geometrically engaging lateral parts of the unit caissons, thereby reducing wave power per unit width that is applied to the caisson breakwater, and a front surface of each unit caisson is provided with an inclined portion for preventing the generation of a stem wave by providing a virtual normal line effect to a direction of a main incident wave.

【Advantageous Effects】

According to the present invention, unit caissons constituting a breakwater are interlocked to integrally move to reduce wave power applied to each unit caisson by a smoothing effect of wave power through the lengthening of the caissons, whereby stability of the caisson breakwater can be increased even when a freak wave or the like approaches.

The caisson breakwater of the present invention can prevent a stem wave from being generated although not arranged perpendicular to a direction of a main incident wave. Accordingly, there are effects in that the caisson breakwater can be economically constructed in shallow waters and a harbor utilization rate can be increased by constructing the caisson breakwater in a place where a harbor entrance can be narrowed, thereby making it possible to freely and economically design and construct the caisson breakwater.

In addition, the present invention has an effect that the generation of a stem wave is prevented to make a transverse wave not be generated on a sea route near a harbor entrance, thereby securing stability in navigation of a ship and essentially blocking a stem wave invading an inside of a harbor to increase a harbor utilization rate.

In brief, the present invention can secure a safety margin for design external force through a lengthening effect by interlocking the unit caissons to more improve stability of

a breakwater, for example, to prevent meandering damage even when a freak wave having greater than design wave height approaches, and promote the economical design and construction and increase a harbor utilization rate through a structure of preventing the generation of a stem wave.

5 **【Description of Drawings】**

Fig. 1 is a schematic view of a conventional caisson breakwater having caissons independently moving.

Figs. 2 (A) and (B) are schematic views illustrating damage states according to the type of the conventional caisson breakwater.

10 Figs. 3a to 4b are views illustrating a damage example of the conventional caisson breakwater, wherein Fig. 3a is a plan view when a design wave approaches, Fig. 3b is a sectional view taken along line I-I of Fig. 3a when a design wave approaches, Fig. 4a is a plan view when a freak wave approaches, and Fig. 4b is a sectional view taken along line II-II of Fig. 4a when a freak wave approaches.

15 Fig. 5 is a view of a configuration of an interlocking caisson breakwater according to Embodiment 1 of the present invention.

20 Figs. 6 and 7 are reference views illustrating a smoothing effect of wave power by lengthening of the interlocking caisson breakwater according to Embodiment 1 of the present invention as compared with the conventional caisson breakwater, wherein Figs. 6 (A) and (B) are comparison views illustrating external force applied to caissons when a design wave approaches, and Figs. 7 (A) and (B) are comparison views illustrating external force applied to caissons when a freak wave approaches.

Fig. 8 is a flow chart illustrating a process of constructing the caisson breakwater according to Embodiment 1 of the present invention.

25 Figs. 9 (A) to (E) are plan views showing another configuration of the caisson breakwater according to Embodiment 1 of the present invention.

Figs. 10 (A) and (B) are plan views showing still another configuration of the caisson breakwater according to Embodiment 1 of the present invention.

30 Figs. 11 (A) to (D) are views illustrating a cause of a stem wave generated along a breakwater.

Figs. 12 and 13 are schematic design plan views illustrating a process of selecting a normal line of a breakwater when a conventional breakwater is designed, wherein Fig. 12 is a view showing that a normal line of the breakwater is arranged perpendicular to a direction of a main incident wave, and Fig. 13 is a view showing that a normal line of the breakwater is arranged to be inclined with respect to a direction of a main incident wave.

Fig. 14 is a schematic plan view when a breakwater is designed using an interlocking caisson breakwater for preventing a stem wave according to Embodiment 2 of the present invention.

Fig. 15 is an enlarged view of portion "A" of Fig. 14.

Fig. 16 is a perspective view showing a structure of interlocking caissons for preventing a stem wave according to Embodiment 2 of the present invention.

Fig. 17 is a view illustrating functional effects of the caisson breakwater for preventing a stem wave according to Embodiment 2 of the present invention.

Figs. 18 and 19 are reference views illustrating a smoothing effect of wave power by the lengthening, which is another effect of the interlocking caisson breakwater for preventing a stem wave according to Embodiment 2 of the present invention, as compared with a conventional general caisson breakwater, wherein Figs. 18 (A) and (B) are comparison views illustrating external force applied to caissons when a design wave approaches, and Figs. 19 (A) and (B) are comparison views illustrating external force applied to caissons when a freak wave approaches.

Fig. 20 is a flow chart illustrating a process of constructing the interlocking caisson breakwater for preventing a stem wave according to Embodiment 2 of the present invention.

Explanation of Reference Numerals for Major Portions Shown in Drawings

1a, 1b: Caisson Breakwater

100a, 100b: Unit Caisson

2: Ship

【Best Mode】

Hereinafter, preferred embodiments of the present invention will be described in detail as follows with reference to Figs. 5 to 10.

Embodiment 1

Fig. 5 is a view of a configuration of a lengthened caisson breakwater according to Embodiment 1 of the present invention, Figs. 6 and 7 are reference views illustrating a smoothing effect of wave power by lengthening of the caisson breakwater according to Embodiment 1 of the present invention as compared with the conventional caisson breakwater, and Fig. 8 is a flow chart illustrating a process of constructing the caisson breakwater according to Embodiment 1 of the present invention.

Referring to the figures, according to Embodiment 1 of the present invention, in a caisson breakwater 1a in which unit caissons which are box-type structures are disposed in a line, the unit caissons 100a can be interlocked to reduce the wave power per unit of width that is applied to the caisson breakwater 1a.

Here, the caisson breakwater 1a is configured so that all the unit caissons have an interlocking effect for integral movement by geometrically mating lateral parts of the unit caissons 100a with each other.

The geometrical engagement of the lateral parts of the unit caissons 100a is obtained by one or more bents provided along the respective lateral parts of the unit caissons adjacent to each other.

That is, as viewed from above, the caisson breakwater 1a has one or more bents along each side surface of the unit caisson 100a.

The caisson breakwater 1a of Embodiment 1 of the present invention has a technical feature in that the unit caissons 100a are interlocked with each other only by geometrical profile modification of the lateral parts of the unit caissons 100a adjacent to each other without providing an additional interlocking device or facility for interlocking the unit caissons 100a.

For example, although Fig. 5 illustrates the case that the box-type unit caissons each merely have a front portion inclined to a left or right side to be interlocked with each other, the geometrical structure of the unit caissons of Embodiment 1 of the present invention is not limited thereto.

That is, referring to views illustrated in Figs. 9 (A) to (E) and Figs. 10 (A) and (B), it can be confirmed that unit caissons 100a-1 to 100a-7 may have various geometrically

modified shapes for interlocking them as shown in the figures.

Particularly, like a caisson breakwater 1a-6 or 1a-7 of Fig. 10, the lateral parts of the unit caissons 100a-6 or 100a-7 may be geometrically engaged to each other by one or more circular arc-shaped curves provided in the lateral parts of the unit caissons adjacent to each other.

A process of constructing the caisson breakwater 1a of Embodiment 1 of the present invention is as follows.

First, the unit caissons 100a according to Embodiment 1 of the present invention, which are structures capable of being interlocked, are manufactured on the land.

Then, the manufactured unit caissons 100a are launched to float. The launched unit caissons 100a are refloated to a breakwater construction place.

After they are refloated to the construction place, the unit caissons 100a are successively sunken and disposed in the construction place. Here, the unit caissons 100a are disposed so that adjacent two of them are geometrically engaged to be interlocked to each other.

After the unit caissons 100a are completely disposed, a fixing process is performed on the unit caissons at the left and right ends to finish the construction of the caisson breakwater 1a of the present invention.

In the meantime, functional effects of the caisson breakwater 1a of Embodiment 1 of the present invention as constructed above are as follows.

In the caisson breakwater 1a of Embodiment 1 of the present invention, although the unit caissons are independently manufactured, after they are constructed as a breakwater, the geometrical engagement of the unit caissons 100a allows the unit caissons to integrally move, thereby obtaining the same functional effect as construction of a lengthened caisson.

In addition, through the caisson lengthening effect, the present invention can have a smoothing effect for reducing wave power applied per unit width, thereby securing a safety margin when a design wave approaches, which means that it is possible to secure stability of the caisson breakwater 1a by the previously secured safety margin even when a freak wave approaches due to a climate change.

That is, the present invention can realize an economical design by manufacturing and constructing the unit caissons 100a and more increase stability of the caisson breakwater 1a through the lengthening effect by geometrically engaging the unit caissons to integrally move.

5 Figs. 6 and 7 illustrate a smoothing effect of wave power by the lengthening of the caisson breakwater according to Embodiment 1 of the present invention as compared with the conventional caisson breakwater. The functional effects of the caisson breakwater of Embodiment 1 of the present invention can be confirmed through Figs. 6 and 7 by comparing external force applied to the caisson when a design wave approaches with
10 external force applied to the caisson when a freak wave approaches.

In Figs. 6 and 7, a magnitude of arrows means a magnitude of applied external force and resistance of the caisson.

A conventional caisson breakwater can resist a design wave height (for example, 8.0 m) when a design wave approaches, but when a freak wave having a wave height (for
15 example, 12.5 m) of not less than the design wave height approaches, meandering damage occurs due to an additional load applied beyond the design resistance by the freak wave.

However, in case of the caisson breakwater 1a of Embodiment 1 of the present invention, the actually applied wave height is reduced as compared with the design wave height by a smoothing effect of wave power due to the caisson lengthening effect, thereby
20 securing a safety margin for design external force. Accordingly, the stability of the breakwater is secured since the meandering damage is prevented when the freak wave having a wave height (for example, 12.5 m) of not less than the design wave height approaches.

That is, when the caisson breakwater of Embodiment 1 of the present invention
25 may be designed to resist the design wave height (for example, 8.0 m) in the same way as the conventional caisson breakwater 10, since the actual wave height applied to the caisson breakwater of Embodiment 1 of the present invention when the design wave approaches is a wave height (for example, 5.1 m) less than the design wave height, the stability of the breakwater is assured by securing the safety margin.

30 For reference, considering the lengthening effect of the caisson breakwater 1a of

Embodiment 1 of the present invention, it seems that it is easy to solve the problem of the breakwater damage due to the conventional independent movement by making the unit caissons 100a constituting the conventional caisson breakwater be a single lengthened caisson. However, this is very difficult due to limitations in structure or construction by an existing technique.

That is, if a unit caisson is too long (for example, 100 m), at the present time, there is a technical limitation in the application of the lengthened caisson in terms of a structural or constructional standpoint, for example since reinforcement is needed due to a disadvantage in structural bending strength, it is difficult to transfer, for example, launch and refloat, the unit caisson, and use of a crane is impossible due to a limitation in weight.

Particularly, if the unit caisson is too long, due to a disadvantage in structural bending strength, economically, a high cost has to be added in a process of reinforcing the unit caisson. Also, in terms of weight, an increase in weight adversely affects the construction including moving and installing the unit caisson, and thus, an economical design is impossible at an existing technical level.

Therefore, the caisson breakwater 1a of Embodiment 1 of the present invention is a very useful invention capable of realizing an economical design in a structural or constructional standpoint and increasing stability of the breakwater even when a freak wave approaches.

Embodiment 2

Hereinafter, another embodiment of the present invention will be described in detail as follows with reference to Figs. 14 to 20.

Fig. 14 is a schematic plan view when a breakwater is designed using a caisson breakwater for preventing a stem wave according to Embodiment 2 of the present invention, Fig. 15 is an enlarged view of portion "A" of Fig. 14, and Fig. 16 is a perspective view showing a structure of interlocking caissons for preventing a stem wave according to Embodiment 2 of the present invention.

In addition, Fig. 17 is a view illustrating effects of the interlocking caisson breakwater for preventing a stem wave according to Embodiment 2 of the present invention, Figs. 18 and 19 are reference views illustrating a smoothing effect of wave

power by the lengthening, which is another effect of the interlocking caisson breakwater for preventing a stem wave according to Embodiment 2 of the present invention, as compared with a conventional general caisson breakwater, and Fig. 20 is a flow chart illustrating a process of constructing the interlocking caisson breakwater for preventing a stem wave according to Embodiment 2 of the present invention.

Referring to Fig. 15, in a caisson breakwater 1b of Embodiment 2 of the present invention configured by disposing box-type unit caissons in a line, a front surface of the unit caisson 100b is provided with an inclined portion, which may provide a virtual normal line effect with respect to a direction of a main incident wave to prevent a stem wave from being generated.

Here, the inclined portion formed on the front surface of the unit caisson 100b is provided to be inclined at any angle with respect to a design normal line direction (breakwater lengthwise direction) of the caisson breakwater, and an inclination angle β of the inclined portion is determined considering a breakwater construction direction and the direction of the main incident wave.

Also, in a rear side of the inclined portion of the unit caisson 100b, one or more bents are provided along both lateral sides of the unit caisson 100b in order that the whole unit caissons integrally move by geometrically mating the lateral parts of the unit caissons 100b with each other.

The caisson breakwater 1b of Embodiment 2 of the present invention also has a technical feature in that the unit caissons 100b are interlocked with each other only by geometrical profile modification of the lateral parts of the unit caissons 100b adjacent to each other without providing an additional interlocking device or facility for interlocking the unit caissons 100b.

A process of constructing the caisson breakwater 1b for preventing a stem wave of Embodiment 2 of the present invention as configured above and its functional effects are as follows.

First, a construction process will be described. The unit caissons 100b according to Embodiment 2 of the present invention having an interlocking structure and a structure for preventing a stem wave are manufactured on the land. Here, the inclination angle of

the inclined portion on the front surface of each unit caisson is determined in a range in which a stem wave is not generated considering an actual construction direction of the breakwater and the direction of the main incident wave.

Then, the manufactured unit caissons 100b are launched to float. The launched
5 unit caissons 100b are then refloated to a breakwater construction place.

After they are refloated to the construction place, the unit caissons 100b are successively sunken and disposed in the construction place. Here, the unit caissons 100b are disposed so that adjacent two of them are geometrically engaged to be interlocked to each other.

10 After the unit caissons 100b are completely disposed, a fixing process is performed on the unit caissons 100b at the left and right ends to finish the construction of the caisson breakwater 1b of Embodiment 2 of the present invention.

In the meantime, functional effects of the caisson breakwater 1b of Embodiment 2 of the present invention constructed as above are as follows.

15 When designed, the caisson breakwater 1b having the structure according to Embodiment 2 of the present invention may cause the ship 2 in and out of harbor not to have an influence on a transverse wave while the breakwater is not arranged perpendicular to the direction of the main incident wave in order not to generate the aforementioned stem wave.

20 That is, in design of a conventional breakwater, when there are economical and technical difficulties, for example, in that the water in the construction place of the breakwater is too deep or the breakwater should be lengthened for calm when the breakwater tries to be constructed perpendicular to the direction of the main incident wave, there is no alternative but to design and construct the breakwater to be inclined with
25 respect to the direction of the main incident wave. Although a stem wave may be generated accordingly, Embodiment 2 of the present invention may allow the breakwater to be designed and constructed to be inclined with respect to the direction of the main incident wave and also effectively prevent the generation of a stem wave.

30 For example, referring to Fig. 14, as the inclined portion is formed on the front surface of the caisson breakwater 1b according to Embodiment 2 of the present invention,

for an incident wave inclined with respect to a normal line of the alternatively designed breakwater, the caisson breakwater 1b acts as being installed at an alternatively designed virtual normal line position, thereby preventing a stem wave from being generated.

Particularly, as shown in Fig. 17, when a wave is incident on condition that an angle α between the breakwater and an incident wave is in a range of $20 \text{ degrees} < \alpha < 45 \text{ degrees}$ in the conventional breakwater, a reflected wave and a stem wave are generated. However, in the caisson breakwater 1b of Embodiment 2 of the present invention, on the same wave incidence condition, if the inclined portion is formed on the front surface of the unit caisson 100b to have the inclination angle of 20 degrees with respect to a alternatively designed normal line of the breakwater, an angle of the incident wave is into a range of $45 \text{ degrees} < \alpha < 70 \text{ degrees}$, correspondingly, thereby generating no stem wave.

That is, the inclined portion on the front surface of the unit caisson 1b of Embodiment 2 of the present invention deflects a normal line to the front surface of the breakwater toward the incident wave direction to provide an effect of increasing an incident angle of a wave. Accordingly, the generation of a stem wave is prevented, whereby an influence of a transverse wave on the ship 2 in and out of harbor is suppressed to secure safe navigation of the ship.

In addition, even when a breakwater is constructed in a place where a stem wave may be generated instead of a place where a harbor entrance can be narrowed and the water is shallow considering a harbor utilization rate and a construction cost according to water depth, the caisson breakwater 1b of Embodiment 2 of the present invention can prevent the generation of a stem wave by increasing an incident angle of a wave, thereby enabling an economical design to be realized.

As described above, the caisson breakwater according to Embodiment 2 of the present invention may realize an actual design and construction of the breakwater in shallow waters in order to increase a harbor utilization rate and reduce a construction cost, and provide an effect of preventing the generation of a stem wave in the same way as when a breakwater is designed and constructed to be arranged perpendicular to the direction of the main incident wave, thereby enabling an economical design and construction of a breakwater.

In the meantime, the caisson breakwater of according to Embodiment 2 of the present invention may secure a safety margin for design external force by reducing damage (i.e., by a smoothing effect) through a lengthening effect by geometrically engaging the lateral parts of the unit caissons 100b in addition to an effect of preventing the generation of a stem wave, thereby increasing stability of the breakwater, for example, preventing meandering damage when a freak wave approaches.

That is, according to Embodiment 2 of the present invention, the generation of a stem wave can be prevented, and further, the stability of the caisson breakwater 1b can be more increased through the lengthening effect by geometrically engaging the unit caissons 100b to integrally move.

Figs. 18 and 19 illustrate a smoothing effect of wave power by lengthening of the caisson breakwater 1b according to Embodiment 2 of the present invention as compared with the conventional caisson breakwater 10. The functional effects of the caisson breakwater 1b according to Embodiment 2 of the present invention can be confirmed through Figs. 18 and 19 by comparing external force applied to the caisson when a design wave approaches with external force applied to the caisson when a freak wave approaches.

The conventional caisson breakwater 10 can resist a design wave height (for example, 8.0 m) when a design wave approaches, but when a freak wave having a wave height (for example, 12.5 m) of not less than the design wave height approaches, meandering damage of the unit caissons 100 occurs due to an additional load applied beyond the design resistance by the freak wave.

However, in case of the caisson breakwater 1b of Embodiment 2 of the present invention, in the same way as the caisson breakwater of Embodiment 1 of the present invention, the actual applied wave height is reduced as compared with the design wave height by a smoothing effect of wave power due to the caisson lengthening effect, thereby securing a safety margin for design external force. Accordingly, the stability of the breakwater is secured since the meandering damage is prevented when the freak wave having a wave height (for example, 12.5 m) of not less than the design wave height approaches.

That is, when the caisson breakwater 1b of Embodiment 2 of the present invention

may be designed to resist the design wave height (for example, 8.0 m) in the same way as the conventional caisson breakwater 10, since the actual wave height applied to the caisson breakwater 1b of Embodiment 2 of the present invention when the design wave approaches is a wave height (for example, 5.1 m) less than the design wave height, the stability of the breakwater is more assured by securing the safety margin.

Also, in the interlocking caisson breakwater for preventing a stem wave of Embodiment 2 of the present invention, it is naturally possible to modify the geometrical shapes for interlocking the unit caissons to other various shapes (see Figs. 9 (A) to (E) and Figs. 10 (A) and (B)).

In the meantime, the present invention is not limited to the aforementioned embodiments, but various changes and modifications may be made without departing from the scope of the invention.

Therefore, the scope of the present invention is not limited to the aforementioned embodiments but defined in the following claims. It will be apparent to those skilled in the art that various modifications and changes can be made thereto within the scope of the present invention and the appended claims.

【Industrial Applicability】

In the caisson breakwater according to Embodiment 1 of the present invention, the unit caissons constituting the breakwater are interlocked to each other to integrally move, so that wave power applied to each unit caisson is reduced by a smoothing effect of wave power through the lengthening of the unit caissons, thereby increasing stability of the caisson breakwater even when a freak wave or the like approaches. Thus, there is a higher industrial applicability since the caisson breakwater can be effectively applied to a place possibly damaged by waves, such as a harbor, a mooring berth, or a lock gate.

Further, since the interlocking caisson breakwater for preventing a stem wave according to Embodiment 2 of the present invention prevents the generation of a stem wave although the breakwater is not arranged perpendicular to a direction of a main incident wave, the breakwater can be economical by being constructed in shallow waters and increase a harbor utilization rate by being constructed in a place where a harbor entrance can be narrowed. In the same way as Embodiment 1, since a safety margin for

design external force can be secured through a caisson lengthening effect obtained by geometrically engaging the unit caissons constituting the breakwater to increase stability of the breakwater, it is possible to provide the economical caisson breakwater freely designed and constructed, which is an invention having a higher industrial applicability.

【CLAIMS】**【Claim 1】**

A caisson breakwater having unit caissons disposed in a line, wherein the unit caissons are interlocked to integrally move by geometrically engaging lateral parts of
5 the unit caissons, the lateral part having one or more bents provided along the lateral parts of the unit caissons adjacent to each other, thereby reducing wave power per unit width that is applied to the caisson breakwater, and a front surface of each unit caisson is provided with an inclined portion having a triangular shape wherein a length of a frontward side of the unit caisson is greater than that of a lateral side of the unit caisson
10 to deflect a normal line to the front surface of the breakwater toward a incident wave direction, thereby providing a virtual normal line effect to a direction of a main incident wave thereby increasing an incident angle of a wave and preventing the generation of a stem wave.

【Claim 2】

15 The caisson breakwater according to Claim 1, wherein an inclination angle of the inclined portion is determined in a range, in which a stem wave is not generated, considering an actual breakwater construction direction and the direction of the main incident wave.

【Claim 3】

20 The caisson breakwater according to Claim 1, wherein the geometrical engagement of the lateral parts of the unit caissons is obtained by means of one or more circular arc-shaped curves provided along the lateral parts of the unit caissons adjacent to each other.

【Claim 4】

A method of constructing a caisson breakwater, comprising:

manufacturing the unit caissons having the interlocking structure according to

Claims 1, 2 or 3 on the land;

5 launching the manufactured unit caissons;

refloating the unit caissons to a caisson breakwater construction place;

successively disposing the unit caissons in the construction place, wherein the
unit caissons adjacent to each other are geometrically engaged to be interlocked; and

performing a fixing process on the unit caissons at the left and right ends of the
10 breakwater.