

MOTION REDUCTION DEVICE AND FLOATING BODY PROVIDED WITH SAME

Technical Field

[0001]

The present invention relates to a motion reduction device mountable on a floating body and a floating body provided with the same.

Background Art

[0002]

Floating body structures (hereinafter referred to as simply “floating bodies”) are widely used as facilities on the waters of oceans, lakes, and rivers. Examples of floating bodies include various workboats, drillships, oil platforms, pontoons, floating storage units, floating docks, and the like. Floating bodies do not require legs in contact with the ocean floor and thus have a simply design. However, morion of floating bodies are induced by incident waves. This has led to the need for a means to reduce the motion of a floating body.

[0003]

The roll motion of the floating body in the waves is the result of wave induced wave exciting force moments. In a typical floating body, because ensuring sufficient damping force of motion in the rolling direction is difficult, when the wave periods are similar to the natural period of the floating body, the amplitude of the rolling increases. In light of this, various technology has been proposed to reduce the motion of a floating body (for example Patent Documents 1 to 4).

[0004]

Patent Document 1 describes a technology in which a board-like member is suspended within a predetermined distance from the ocean floor to reduce motion. It is designed so that the fluid forces acting on the board-like member increase the additional mass and viscous damping forces.

Patent Document 2 describes a technology in which an inclined board-like member is provided on the side of the floating body incident to the waves to reduce motion. The inclined board-like member is inclined upstream in the advancing direction of the waves and extends from near the water line to the approximately the depth of the bottom surface.

[0005]

Patent Document 3 describes a technology in which a vertical board-like member is provided on the lower end of the side of the floating body incident to the waves. The vertical board-like member extends below the bottom surface of the

floating body and is disposed allowing for a gap through which water can pass between the floating body and the vertical board-like member. The vertical board-like member can be inclined and inclining the vertical board-like member can reduce motion.

Patent Document 4 describes a technology for reducing motion in which the ratio between the width and draft of a box-like floating body is set in relation to the ratio between the length and the width of the box-like floating body so that the effects of the wave forces are decreased.

Citation List Patent Document

[0006]

Patent Document 1: Japanese Patent Publication No. 4798573B

Patent Document 2: Japanese Patent Publication No. 4022973B

Patent Document 3: Japanese Patent Publication No. 3697091B

Patent Document 4: Japanese Patent Publication No. 3198698B

Summary of Invention Technical Problems

[0007]

However, the technology of Patent Document 1 is not easily installed on motion reduction devices at sea. In the technology of Patent Document 2, the side portion of the floating body below the water line protrudes out. When the floating body is berthing, the protruding portion may obstruct berthing with objects near the water line. In the technology of Patent Document 3, the vertical board-like member may act as a resisting element when the floating body is towed. Additionally, in the technologies of Patent Documents 1 to 3, the motion reduction devices tend to be large in scale. In the technology of Patent Document 4, the degrees of freedom in the design of the shape of the floating body are reduced.

[0008]

To solve to problems described above, the present invention provides a motion reduction device that is not required to be large-scale, has a simple structure that provides a reliable motion reduction for the floating body, minimizes or prevents an increase in resistance when the floating body is towed, and is not an obstruction when berthing; and a floating body provided with the same.

Solution to Problem

[0009]

(1) In order to achieve the objects described above, a motion reduction device according to an embodiment of the present invention comprises:

a board-like portion that, when in an operating state, is disposed at a corner portion where a side surface and a bottom surface of a floating body meet with a gap formed between a base end of the board-like portion and the corner portion, a leading end of the board-like portion protruding in a direction outward from the side surface of the floating body; and

a support portion joined to the floating body that supports the board-like portion;

an upward facing surface of the board-like portion functioning as a guiding surface to converge a flow of water from an advancing wave advancing toward the side surface from outside of the side surface and guide the flow of water toward the gap;

a downward facing surface of the board-like portion functioning as a resistance surface to block the flow of water from a retreating wave retreating to the outside from the bottom surface;

the support portion comprising a movement mechanism that moves the board-like portion between an operating position and a housing position where the board-like portion is housed in a recess formed near the corner portion of the floating body.

[0010]

(2) Preferably, the movement mechanism comprises a link member disposed between the board-like portion and a wall portion of the recess in a manner that allows the link member to swing freely, and a telescopic actuator disposed next to the link member between the board-like portion and the wall portion of the recess.

[0011]

(3) Preferably, the board-like portion comprises an outer surface with a shape that conforms to a shape of an outer surface of the floating body around a housing region where the recess is formed when the board-like portion is in the housing position.

[0012]

(4) Preferably, the board-like portion has a flat board-like shape and, in an operating state, has a horizontal orientation when in the operating position, and the housing region of the board-like portion is a planar region formed in the outer surface of the floating body.

[0013]

(5) Preferably, the board-like portion has a flat board-like shape and, in an operating state, has an inclined orientation with the leading end extending in a

direction outward from the side surface of the floating body and downward when in the operating position, and the housing region of the board-like portion is a planar region formed in the outer surface of the floating body.

[0014]

(6) Preferably, the board-like portion has a bent shape when in the operating position and comprises an inclined portion that extends diagonally downward from near the corner portion outward from the side surface of the floating body and a vertical portion that extends vertically downward from the inclined portion where the board-like portion bends, and the housing region of the board-like portion is the corner portion of the floating body formed into a bent shape.

[0015]

(7) Preferably, the gap between a base portion of the board-like portion and the corner portion is set to a size small enough so that the flow of water guided through the gap by the upward facing surface of the board-like portion and advancing under the bottom surface is formed into a high speed laminar flow at a region near the corner portion of the bottom surface.

[0016]

(8) Preferably, the board-like portion is disposed extending the entire length of the side surface of the floating body.

[0017]

(9) A floating body according to an embodiment of the present invention comprises:

a corner portion where a side surface and a bottom surface meet;
the motion reduction device described above mounted at the corner portion.

[0018]

(10) Preferably, the motion reduction device is mounted on the side surfaces on both sides of the floating body.

Advantageous Effects of Invention

[0019]

In a motion reduction device according to an embodiment of the present invention, the upward facing surface of the board-like portion functions as a guiding surface to converge the flow of water advancing toward the side surface from outside of the side surface and guide the flow of water toward the gap formed between the base portion of the board-like portion and the corner portion. The flow of water converges in the gap, increases in speed, and advances from the gap down the bottom surface. The flow of water flows at high speeds along the bottom surface and creates negative pressure under the bottom surface near the corner portion. This acts on the

flow of water to lower the bottom surface near the corner portion. Advancing waves act on the floating body to raise the side surface, however the negative pressure acts on the floating body to offset this. As a result, the motion of the floating body by the advancing wave is suppressed.

[0020]

Additionally, the downward facing surface of the board-like portion functions as a resistance surface to block the flow of water from retreating waves retreating to the outside from the bottom surface. As a result, the flow of water presses against the resistance surface, which acts on the floating body to push up the bottom surface near the corner portion. Retreating waves act on the floating body to lower the side surface, however the force of the flow of water presses on the resistance surface acts on the floating body to offset this. As a result, the motion of the floating body by the retreating wave is suppressed.

[0021]

Additionally, the movement mechanism can move the board-like portion from the operating position to the housing position. Thus, when the floating body is towed, the board-like portion is housed and the board-like portion does not act as a resisting element, allowing the floating body to be smoothly towed without a negative impact on fuel economy. Additionally, when in the operating position, the board-like portion protrudes in a direction outward from the side surface and thus obstructs berthing. However, the board-like portion can be housed, thus allowing the floating body to be berthed without obstacle.

Brief Description of Drawings

[0022]

FIG. 1 is a perspective view illustrating a motion reduction device according to an embodiment of the present invention and a floating body provided with the same.

FIGS. 2A to 2D are cross-sectional views of floating bodies for explaining the operating principle of a motion reduction device according to an embodiment of the present invention. FIG. 2A is a drawing for explaining how a floating body without the motion reduction device rocks. FIGS. 2B to 2D are drawings for explaining the operating principle of the motion reduction device.

FIGS. 3A and 3B are drawings illustrating the configuration of a motion reduction device according a first embodiment of the present invention. FIG. 3A is a cross-sectional view illustrating a floating body with a fin (board-like portion) housed in a housing position. FIG. 3B is a cross-sectional view illustrating the floating body with the fin in an operating position.

FIGS. 4A to 4C are drawings illustrating the configuration of a motion reduction device according a second embodiment of the present invention. FIG. 4A is a cross-sectional view illustrating a floating body with a fin (board-like portion) housed in a housing position. FIGS. 4B and 4C are cross-sectional views illustrating the floating body with the fin in an operating position.

FIGS. 5A and 5B are drawings illustrating the configuration of a motion reduction device according a third embodiment of the present invention. FIG. 5A is a cross-sectional view illustrating a floating body with a fin (board-like portion) in an operating position. FIG. 5B is a cross-sectional view illustrating the floating body with the fin housed in a housing position.

FIG. 6 is a cross-sectional view illustrating the shape of the fins (board-like portions) according to the embodiments.

FIG. 7 is a cross-sectional view illustrating the shape of the fin (board-like portion) according to the third embodiment.

Description of Embodiments

[0023]

Embodiments of the present invention will be described below with reference to the drawings.

Herein, “vertically upward” refers to the top or upper direction. “Vertically downward” refers to the bottom or lower direction. The direction toward the center line of center of the floating body in the width direction with reference to the side surfaces of the floating body is referred to as “inward” or “inner side”. The opposite side or the direction away from the center line is referred to as “outward” or “outer side”.

[0024]

The embodiments are mere examples and should not be construed to exclude the application of various modifications or techniques that are not described in the embodiments. The individual features of the embodiments may be modified in various manners without departing from the gist and/or selectively employed as necessary or properly combined with one another.

[0025]

General Description of Motion Reduction Device

First, a general description of a motion reduction device according to embodiments will be given with reference to FIGS. 1 and 2A to 2D.

FIG. 1 is a perspective view illustrating a floating body (floating body structure) provided with a motion reduction device according to an embodiment. As illustrated in FIG. 1, a floating body 1 is box shaped (approximately a rectangular

parallelepiped) and includes an upper surface portion (upper surface) 2, a lower surface portion (lower surface) 3, side surface portions (side surfaces) 4, 4, and end surface portions (end surfaces) 5, 5. An example in which a motion reduction device 10 is mounted on the side surface portions 4, 4 is illustrated.

[0026]

As illustrated in FIGS. 1 and 2A to 2D, the motion reduction device 10 includes a fin (board-like portion) 20. The fin 20 is supported by a support portion (not illustrated in FIG. 1) joined to the floating body 1. The fin 20 is disposed at a corner portion 6 of the floating body 1 where the side surface 4 and the bottom surface 3 meet with a gap 7 formed between a base end 21 and the corner portion 6 and is used with a leading end thereof protruding in a direction outward from the side of the floating body 1. In this example, the fin 20 has a flat board-like shape and disposed in a horizontal orientation.

[0027]

An upward facing surface 20a of the fin 20 functions as a guiding surface to converge the flow of water from an advancing wave advancing toward the side surface 4 from outside of the side surface 4 and guide the flow of water toward the gap 7.

Thus, the size of the gap 7 is preferably small so that the flow of water guided through the gap 7 by the upward facing surface 20a of the fin 20 advancing under the bottom surface 3 forms into a high speed laminar flow at a region near the corner portion 6 of the bottom surface 3.

Additionally, a downward facing surface 20b of the fin 20 functions as a resistance surface to block the flow of water from a retreating wave retreating outward from the bottom surface 3.

[0028]

In FIG. 2A, an advancing wave pushes against the side surface 4 from the side (left side in FIG. 2A). As illustrated by the white solid arrow in FIG. 2A, a wave exciting force moment M1 in the clockwise direction acts on the floating body 1 such that if the motion reduction device 10 was not provided, the floating body 1 would roll.

[0029]

Alternatively, when the motion reduction device 10 is mounted on the floating body 1 as illustrated in FIG. 2B, the guiding surface 20a of the fin 20 converges the flow of water from an advancing wave advancing on the side surface 4 from outside of the side surface 4 and guides the flow of water toward the gap 7 between the base portion 21 of the fin 20 and the corner portion 6 (see FIG. 2D). The flow of water converges at the gap 7 as illustrated by the line arrow while increasing in speed, and

advances under the bottom surface 3 from the gap 7. As a result, the flow of water flows along the bottom surface 3 forming a high speed laminar flow. Negative pressure thus formed under the bottom surface 3 near the corner portion 6 creates a lowering force $F1$ that acts on the floating body 1 to lower the bottom surface 3 near the corner portion 6. The force $F1$ offsets the wave exciting force moment $M1$, thus suppressing the motion of the floating body 1 by the advancing wave.

[0030]

Additionally, as illustrated in FIG. 2C, the resistance surface 20b of the fin 20 blocks the flow of water of the retreating wave retreating outward from the bottom surface 3. The flow of water presses against the resistance surface 20b, the region under the bottom surface 3 near the corner portion 6 (see FIG. 2D) becomes a region of high pressure creating a raising force $F2$ that acts on the floating body 1 to push up the bottom surface 3. A wave exciting force moment $M2$ in the counter-clockwise direction induced by the retreating wave on the floating body 1 is offset by the force $F2$. As a result, the motion of the floating body 1 by the retreating wave is suppressed.

[0031]

In other words, as illustrated in FIG. 2D, the motion reduction device 10 is configured so that a flow of water $WF1$ from an advancing wave advancing toward the side surface 4 from outside of the side surface 4 is converged by the guiding surface 20a of the fin 20 and guided from the gap 7 under the bottom surface 3, and a flow of water $WF2$ from a retreating wave retreating outward from the bottom surface 3 is blocked from retreating out through the gap 7 by the resistance surface 20b of the fin 20.

[0032]

In such a manner, by the wave exciting force moments $M1$, $M2$ of the advancing wave and the retreating wave and the forces $F1$, $F2$ of the flow of water offsetting one another, the motion of the floating body 1 is reduced.

In each of the embodiments below, the motion reduction device includes the fin 20 for reducing the motion of the floating body 1 in this manner. However, the fin 20 is characterized by being moveable between an operating position to a housing position where the fin 20 is housed in a recess formed in the floating body 1.

[0033]

First Embodiment

First, a motion reduction device 10A according to a first embodiment of the present invention will be described. As illustrated in FIGS. 3A and 3B, the motion reduction device 10A is mounted only on the side surface 4 on one side of the floating body 1 and includes the fin 20 and a support portion 30A joined to the floating body 1

that supports the fin 20. The floating body 1 is used while moored in a manner such that the side surface 4 on the one side where the motion reduction device 10A is mounted faces the open water from where the waves advance.

[0034]

As described above, the fin 20 in the operating position is disposed in a horizontal orientation protruding out from the corner portion 6 in a direction outward from the side surface 4 of the floating body 1. However, the fin 20 may be disposed extending in a direction outward from the side surface 4 at a downward incline.

The upward facing surface 20a of the fin 20 functions as a guiding surface to converge the flow of water from an advancing wave advancing toward the side surface 4 from outside of the side surface 4 and guide the flow of water toward the gap 7. The downward facing surface 20b of the fin 20 functions as a resistance surface to block the flow of water from a retreating wave retreating outward from the bottom surface 3.

[0035]

The fin 20 extends in the longitudinal direction of the floating body 1 (direction in which the corner portion 6 extends) and extends the entire length or approximately the entire length of the floating body 1 in the longitudinal direction. The fin 20 is supported by the support portion 30A at a plurality of positions in the longitudinal direction such as three positions or more including at positions near both end portions and an intermediate portion. Here, the fin 20 is a single member that extends the entire length or approximately entire length of the floating body 1. However, the fin 20 may be divided into a plurality of members in the longitudinal direction, with each supported by a support portion 30A in a similar manner as described above.

[0036]

The support portion 30A includes a movement mechanism 32A that moves the fin 20 between an operating position and a housing position where the fin 20 is housed in a recess 3A formed in the bottom surface 3 of the floating body 1.

The movement mechanism 32A includes a link member 32 disposed between the upper surface of the fin 20 and the wall portion of the recess 3A formed in the bottom surface 3 of the floating body 1 in a manner that allows the link member 32 to freely swing, and a hydraulic cylinder (telescopic actuator) 31A disposed next to the link member 32 between the upper surface of the fin 20 and the wall portion of the recess 3A.

[0037]

When the hydraulic cylinder 31A retracts, the fin 20 is housed inside the recess 3A, and in this housing position, the bottom surface of the fin 20 is positioned

flush with the bottom surface 3. In other words, the fin 20 includes an outer surface with a shape that conforms to the shape of the outer surface of the floating body 1 around the housing region where the recess 3A is formed. When the hydraulic cylinder 31A is extended, the fin 20 is brought out from the recess 3A to the operating position with the fin 20 being positioned slightly below the bottom surface 3 and protruding out past the side surface 4. The hydraulic cylinder 31A is equipped with a lock mechanism that restricts the extending and retracting of the hydraulic cylinder 31A, and in the housing position and the operating position, the position of the fin 20 is maintained by the lock mechanism.

[0038]

The motion reduction device 10A according to the first embodiment of the present invention is configured as described above. As illustrated in FIG. 3B, when the motion reduction device 10A is in operation, the hydraulic cylinder 31A of the movement mechanism 32A is extended to set the fin 20 to the predetermined operating position, and the hydraulic cylinder 31A is fixed by the lock mechanism. This allows the motion reduction device 10A to provide a motion reduction effect to the floating body 1 in the manner described above.

[0039]

When the floating body 1 is towed or during berthing, as illustrated in FIG. 3A, the hydraulic cylinder 31A of the movement mechanism 32A is retracted, and the fin 20 is housed in the housing position inside the recess 3A. In this state, the bottom surface of the fin 20 is positioned flush with the bottom surface 3. Thus, when the floating body 1 is towed, the fin 20 does not act as a resisting element, and the floating body 1 can be smoothly towed without a negative impact on fuel economy.

[0040]

Additionally, when in the operating position, the fin 20 protrudes in a direction outward from the side surface 4 and thus obstructs berthing. However, when berthing, the fin 20 can be housed in the housing position within the recess 3A, thus allowing the floating body 1 to be berthed without obstruction.

[0041]

In the present embodiment, the motion reduction device 10A is mounted only on the side surface 4 on one side of the floating body 1. Thus, the installation cost of the motion reduction device 10A can be suppressed. The motion reduction device 10A may of course be mounted on the side surfaces 4 on both sides of the floating body 1 so that the floating body 1 may be used with either side surface 4 facing the open water.

[0042]

Second Embodiment

Next, a second embodiment of the present invention will be described. In the present embodiment, as illustrated in FIGS. 4A to 4C, the motion reduction device 10A similar to that of the first embodiment is mounted on the side surfaces 4 on both sides of the floating body 1. The motion reduction devices 10A on both side surfaces 4 are symmetrical in shape and have the same structure, thus a description is omitted.

[0043]

A motion reduction device 10B according to the second embodiment of the present invention has the configuration as described above. Thus, as illustrated in FIGS. 4B and 4C, by setting the fin 20 on the required side surface 4 to the predetermined operating position, the floating body 1 is provided with a motion reduction effect in a similar manner to the first embodiment.

[0044]

When the floating body 1 is towed or during berthing, as illustrated in FIG. 4A, the movement mechanisms 32A are actuated, and the fins 20 are housed. Thus, when the floating body 1 is towed, the floating body 1 can be smoothly towed without a negative impact on fuel economy, and during berthing of the floating body 1, the floating body 1 can be berthed without obstruction.

[0045]

Third Embodiment

Next, the motion reduction device 10B according to a third embodiment of the present invention will be described. The motion reduction device 10B differs from that of the first and second embodiment in that a fin 20B has a different shape and the housing region in the floating body 1 is different.

[0046]

As illustrated in FIG. 5A, the fin 20B of the present embodiment includes an inclined portion 22 that, when the fin 20B is in the operating position, extends from a position near the corner portion 6 downward at an incline out past the side surface 4 of the floating body 1 and a vertical portion 23 that extends vertically downward from the bend at the leading end of the inclined portion 22. The base end 21 is disposed with the gap 7 formed between the base end 21 and the corner portion 6.

[0047]

A movement mechanism 32B includes a bent link member 33 disposed between the fin 20 and the wall portion of a recess 3B formed in the corner portion 6 of the floating body 1 in a manner that allows the bent link member 33 to freely swing, and a hydraulic cylinder (telescopic actuator) 31B disposed next to the bent link member 33 between the fin 20 and the wall portion of the recess 3b.

[0048]

As illustrated in FIG. 5B, when the hydraulic cylinder 31B retracts, the fin 20 is housed inside the recess 3B, and in this housing position, the outer surface of the inclined portion 22 and the vertical portion 23 of the fin 20 are positioned substantially flush with the outer surface of the corner portion 6. As illustrated in FIG. 5A, when the hydraulic cylinder 31B is extended, the fin 20 is brought out from the recess 3B to the operating position with the fin 20 being positioned slightly below the bottom surface 3 and protruding out past the side surface 4. The hydraulic cylinder 31B is also equipped with a lock mechanism that restricts the extending and retracting of the hydraulic cylinder 31B, and in the housing position and the operating position, the position of the fin 20 is maintained by the lock mechanism.

[0049]

An upward facing surface 22a of the fin 20B (in other words, the upward facing surface of the inclined portion 22 that faces diagonally outward) in the operating position functions as a guiding surface to converge the flow of water from an advancing wave advancing toward the side surface 4 from outside of the side surface 4 and guide the flow of water toward the gap 7.

[0050]

Thus, the size of the gap 7 is preferably small so that the flow of water guided through the gap 7 by the upward facing surface 22a of the fin 20 advancing under the bottom surface 3 forms into a high speed laminar flow at a region near the corner portion 6 of the bottom surface 3.

[0051]

Additionally, a downward facing surface 22b of the fin 20B (the downward facing surface of the inclined portion 22 that faces diagonally inward) and an inward facing surface 23b of the vertical portion 23 in the operating position function as resistance surfaces to block the flow of water from a retreating wave retreating outward from the bottom surface 3.

[0052]

The motion reduction device 10B according to the third embodiment of the present invention has the configuration as described above. Thus, as illustrated in FIG. 5A, by setting the fin 20B to the predetermined operating position, the motion reduction device 10B provides the floating body 1 with a motion reduction effect in a similar manner to the first embodiment.

[0053]

Additionally, when the floating body 1 is towed or during berthing, as illustrated in FIG. 5B, the hydraulic cylinder 31B of the movement mechanism 32B is actuated, and the fin 20 is housed in the housing position inside the recess 3B. In this state, the outer surface of the fin 20B is positioned substantially flush with the

outer surface of the corner portion 6 of the floating body 1. In other words, the fin 20B includes an outer surface with a shape that conforms to the shape of the outer surface of the floating body 1 around the housing region formed in the recess 3B. Thus, when the floating body 1 is towed, the resistance from the fin 20B is reduced, and the floating body 1 can be smoothly towed without a negative impact on fuel economy.

[0054]

Additionally, when in the operating position, the fin 20B protrudes in a direction outward from the side surface 4 and thus obstructs berthing. However, when berthing, the fin 20B can be housed in the housing position within the recess 3B, thus allowing the floating body 1 to be berthed without obstruction.

[0055]

Note that in the present embodiment, in a similar manner to that of the first embodiment, the motion reduction device 10B is mounted on the side surface 4 on only one side of the floating body 1. However, in a similar manner to that of the second embodiment, the motion reduction device 10B may be mounted on the side surfaces 4, 4 on both sides of the floating body 1.

[0056]

Shape and Disposition of Fin

Here, the shape and disposition of the fin will be described.

FIG. 6 illustrates a comparison between the flat board-like fin 20 according to the first and second embodiment as seen in a horizontal cross-sectional view in the operating state inclined past the horizontal with the outer side lowered slightly, and the fin 20B according to the third embodiment as seen in a horizontal cross-sectional view in the operating state.

[0057]

The fin 20B has a greater motion reduction effect. However, the fin 20 protrudes out less and thus can have a simpler housing mechanism.

Here, the shape and disposition of the fin 20B will be further described.

As described above, the fin 20B includes the inclined portion 22 that, when the fin 20B is in the operating position, extends from a position near the corner portion 6 downward at an incline out past the side surface 4 of the floating body 1 and the vertical portion 23 that extends vertically downward from the bend at the leading end of the inclined portion 22.

[0058]

Such a structure including the inclined portion 22 and the vertical portion 23 has the greatest motion reduction effect in terms of cross sectional shape, which has

been verified by a test (simulation). Furthermore, optimum values such as dimensions of all of the components have been determined by a test (simulation).

[0059]

As illustrated in FIG. 7, the depth of the floating body 1 from the water surface is d , the vertical position of the base end 21 of the fin 20 from the floating body 1 measured downward from the bottom surface 3 of the floating body 1 expressed as a position number is s , the horizontal position of the base end 21 of the fin 20 from the floating body 1 measured inward with respect to the floating body 1 from the side surface 4 of the floating body 1 expressed as a position number is x_0 , the length of the inclined portion 22 is b , the inclination angle of the inclined portion 22 with respect to the vertical is θ , and the length of the vertical portion 23 is h .

Tests (simulations) were conducted varying these parameters. On the basis of the results, the following values were found as parameters which provide an excellent motion reduction effect.

[0060]

[Table 1]

Control factor			Value range
Shape parameter	Width of vertical portion	h/b	$0 < h/b \leq 1$
	Width of inclined portion	b/d	$0.05 \leq b/d \leq 0.5$
	Inclination of inclined portion	θ	$0^\circ \leq \theta \leq 90^\circ$
Disposition parameter	Width of gap	s/d	$0.01 \leq s/d \leq 0.2$
	Forward/backward position	x_0	$0 \leq x_0 \leq b \times \sin\theta$

[0061]

The shape and disposition as indicated here are preferable.

[0062]

Other

The embodiments of the present invention have been described above. Note that the present invention may be implemented by modifying the embodiments or combining the embodiments with one another as appropriate without departing from the gist of the invention.

For example, in the embodiments described above, the cross-sectional shape and disposition of the fins 20, 20B are set in a specific manner. However, the cross-sectional shape and disposition of the fins 20, 20B are not limited to this manner.

[0063]

The fin is at least configured in a manner such that the fin is disposed with a gap between the base end and the corner portion of the floating body, the leading end protrudes in a direction outward from the side surface of the floating body when in the operational state, the upward facing surface of the fin functions as a guiding surface to converge the flow of water from an advancing wave advancing toward the side surface from outside of the side surface and guide the flow of water toward the gap, and the downward facing surface of the fin functions as a resistance surface to block the flow of water from a retreating wave retreating outward from the bottom surface.

Reference Signs List

[0064]

- 1 Floating body
- 2 Upper surface portion (upper surface)
- 3 Lower surface portion (lower surface)
- 4 Side surface portion (side surface)
- 5 End surface portion (end surface)
- 10, 10A, 10B Motion reduction device
- 20, 20B Fin (board-like portion)
- 21 Base end of fin 20, 20B
- 22 Inclined portion
- 22a Upward facing surface of inclined portion 22 (guiding surface)
- 22b Downward facing surface of inclined portion 22 (resistance surface)
- 23 Vertical portion
- 23b Inward facing surface of vertical portion 23 (resistance surface)
- 30A, 30B Support portion
- 31A, 31B Hydraulic cylinder (telescopic actuator)
- 32A, 32B Movement mechanism
- 31, 33 Link member

Claims

[Claim 1]

A motion reduction device, comprising:

a board-like portion that, when in an operating state, is disposed at a corner portion where a side surface and a bottom surface of a floating body meet with a gap formed between a base end of the board-like portion and the corner portion, a leading end of the board-like portion protruding in a direction outward from the side surface of the floating body; and

a support portion joined to the floating body that supports the board-like portion;

an upward facing surface of the board-like portion functioning as a guiding surface to converge a flow of water from an advancing wave advancing toward the side surface from outside of the side surface and guide the flow of water toward the gap;

a downward facing surface of the board-like portion functioning as a resistance surface to block the flow of water from a retreating wave retreating to the outside from the bottom surface;

the support portion comprising a movement mechanism that moves the board-like portion between an operating position and a housing position where the board-like portion is housed in a recess formed near the corner portion of the floating body.

[Claim 2]

The motion reduction device according to claim 1, wherein

the movement mechanism comprises a link member disposed between the board-like portion and a wall portion of the recess in a manner that allows the link member to swing freely, and a telescopic actuator disposed next to the link member between the board-like portion and the wall portion of the recess.

[Claim 3]

The motion reduction device according to claim 1 or 2, wherein

the board-like portion comprises an outer surface with a shape that conforms to a shape of an outer surface of the floating body at a housing region around where the recess is formed when the board-like portion is in the housing position.

[Claim 4]

The motion reduction device according to any one of claims 1 to 3, wherein

the board-like portion has a flat board-like shape and, in an operating state, has a horizontal orientation when in the operating position, and the housing region of the board-like portion is a planar region formed in the outer surface of the floating body.

[Claim 5]

The motion reduction device according to any one of claims 1 to 3, wherein the board-like portion has a flat board-like shape and, in an operating state, has an inclined orientation with the leading end extending in a direction outward from the side surface of the floating body and downward when in the operating position, and the housing region of the board-like portion is a planar region formed in the outer surface of the floating body.

[Claim 6]

The motion reduction device according to any one of claims 1 to 3, wherein the board-like portion has a bent shape when in the operating position and comprises an inclined portion that extends diagonally downward from near the corner portion outward from the side surface of the floating body and a vertical portion that extends vertically downward from the inclined portion where the board-like portion bends, and the housing region of the board-like portion is the corner portion of the floating body formed into a bent shape.

[Claim 7]

The motion reduction device according to any one of claims 1 to 6, wherein the gap between a base portion of the board-like portion and the corner portion is set to a size small enough so that the flow of water guided through the gap by the upward facing surface of the board-like portion and advancing under the bottom surface is formed into a high speed laminar flow at a region near the corner portion of the bottom surface.

[Claim 8]

The motion reduction device according to any one of claim 1 to 7, wherein the board-like portion is disposed extending the entire length of the side surface of the floating body.

[Claim 9]

A floating body, comprising:

a corner portion where a side surface and a bottom surface meet;

the motion reduction device according to any one of claims 1 to 8 mounted near the corner portion.

[Claim 10]

The floating body according to claim 9, wherein
the motion reduction device is mounted on the side surfaces on both sides of the floating body.