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DESCRIPTION



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Fender for ship

Technical Field

5 The present invention relates to a fender for ship, and more particularly, it relates to a fender fixed to a quay to be used as a buffer when a ship or the like comes alongside the quay or moors at the quay.

10 Background Technique

A fender for ship absorbing energy and buffering a shock when a ship comes alongside the quay or the like thereby protecting the hull of the ship is frequently used.

15 Fig. 6 is a diagram showing the sectional structure of such a fender, which is described in Japanese Patent Laying-Open No. 2001-172939 as prior art.

Referring to Fig. 6, the fender 61 is formed by a cylindrical first supporting part 91 having a constant external shape and a constant thickness and a hollow
20 truncated-conical second supporting part 92, having a constant thickness, spreading from the base end of the first supporting part 91 toward a locating plane Q of a quay or the like. The so-called circle fender integrally formed by an elastic material such as rubber is widely and
25 generally used as the fender 61. A receiving member such

as a receiving plate is mounted on the forward end of the first supporting part 91 to be used, although this receiving member is not shown in Fig. 1.

When receiving compressive force from the ship coming
5 alongside the quay, such a circle fender 61 first causes reaction force against this compressive force, starts bending on the boundary portion between the first supporting part 91 and the second supporting part 92 and a substantially central position along the height direction
10 in an intermediate portion of the second supporting part 92, and buckles when the reaction force cannot finally withstand the compressive force. Then, the overall fender is deformed until the same is folded substantially with no clearance, and further compressively deformed as a lump of
15 rubber.

Fig. 7 shows the result of the process of this deformation with a displacement-reaction force characteristic curve showing the displacement of the fender 61 resulting from compression and the reaction
20 force caused in the fender 61 at this time. In other words, a period between the ordinary state shown in Fig. 6 and a point immediately before buckling of the bent portion corresponds to the interval between the origin O and a maximum point A in Fig. 7. In this period, the fender 61
25 bent by receiving the compressive force causes the

reaction force for returning to the original state, and hence the reaction force is increased.

When buckling, however, the fender 61 loses most of the aforementioned reaction force and hence the reaction force of the fender 61 is reduced until the overall fender 61 is crushed and folded. In other words, the fender 61 follows the process from the maximum point A to a minimum point C. When completely folded, the overall fender 61 in turn behaves as a lump of rubber as hereinabove described, to cause large reaction force again. In other words, it follows that the reaction force is one-sidedly increased through a point B after passing through the minimum point C.

When the fender having such a characteristic curve as described above is used in practice, the usable range thereof is generally from the origin O to the point B where the reaction force increased again through the point C exhibits the same reaction force value as the maximum point A. In terms of the displacement, the usable range is regulated to the range between the origin O and the displacement D. This regulation is employed since there is a possibility that the reaction force is excessively increased to cause a problem such as damage of the hull after the displacement D.

A portion corresponding to the area S_1 of a region

partitioned by this characteristic curve, the horizontal axis passing through the origin O and a vertical axis passing through the point B shows the quantity of energy absorbable by such a fender in the allowed range up to the displacement D. Therefore, it is necessary to increase the reaction force while increasing the displacement thereby increasing the absorbed energy as an effective fender.

Accordingly, an object of the present invention is to provide a fender having a large value of a maximum point A while efficiently increasing the value of displacement D in a displacement-reaction force characteristic curve.

Disclosure of the Invention

In order to attain the aforementioned object, a fender according to a first aspect of the present invention is a fender for ship, integrally formed by an elastic body such as rubber, comprising a discoid receiving part, a hollow truncated-conical first supporting part connected to the receiving part to outwardly spread from the outer peripheral edge of the receiving part and a hollow truncated-conical second supporting part connected to the first supporting part to outwardly spread from the outer peripheral edge of the first supporting part through a first step part, while the inner peripheral walls of the first supporting part and

the second supporting part have second step parts
outwardly spreading in the second supporting part, the
inclination of the outer peripheral wall of the first
supporting part is 15° , and the inclination of the outer
5 peripheral wall of the second supporting part is 15 to
17.5°.

According to this structure, reaction force is
increased and the value of usable displacement is
increased in a displacement-reaction force curve.

10 A fender according to a second aspect of the present
invention is a fender for ship, integrally formed by an
elastic body such as rubber, comprising a discoid
receiving part, a hollow truncated-conical first
supporting part connected to the receiving part to
15 outwardly spread from the outer peripheral edge of the
receiving part and a hollow truncated-conical second
supporting part connected to the first supporting part to
outwardly spread from the outer peripheral edge of the
first supporting part through a first step part, while the
20 inner peripheral walls of the first supporting part and
the second supporting part have second step parts
outwardly spreading in the second supporting part, the
first supporting part is connected through a third step
part horizontally and outwardly extending from the outer
25 peripheral edge of the receiving part, the inclination of

the outer peripheral wall of the first supporting part is 15°, the inclination of the outer peripheral wall of the second supporting part is 15°, and the ratio of the horizontal length A of the third step part to the diameter D of the receiving part is 0 to 0.04 %.

According to this structure, a displacement-reaction force curve suitable to the fender is obtained.

In a fender according to a third aspect of the present invention, the inclination of the inner peripheral walls closer to the receiving part is 7.3° with respect to the second step parts in the structure according to the first aspect or the second aspect of the present invention.

According to this structure, the reaction force is further increased on a stable displacement-reaction force curve.

As hereinabove described, the reaction force is increased while the value of the displacement is also increased according to the first aspect of the present invention, thereby providing an effective fender having a large amount of absorbed energy.

According to the second aspect of the present invention, a displacement-reaction force curve suitable to a fender is obtained, thereby providing a fender having a stable amount of absorbed energy.

According to the third aspect of the present

invention, the reaction force is further increased in a stable displacement-reaction force curve in addition to the effect of the first aspect or the second aspect of the present invention, thereby providing an efficient fender.

5 The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

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Brief Description of the Drawings

Fig. 1 is a diagram showing a schematic sectional structure of a fender according to a first embodiment of the present invention.

15 Fig. 2 is a diagram showing displacement-reaction force curves in a case of varying the inclination of a second supporting part with respect to the fender shown in Fig. 1.

20 Fig. 3 is a diagram showing displacement-reaction force curves in a case of varying the inclination of an upper inner peripheral wall with respect to the fender shown in Fig. 1.

25 Fig. 4 is a diagram showing a schematic sectional structure of a fender according to a second embodiment of the present invention.

Fig. 5 is a diagram showing displacement-reaction force curves in a case of varying the length of a third step part with respect to the fender shown in Fig. 4.

Fig. 6 is a diagram showing a schematic sectional structure of a conventional fender.

Fig. 7 is a diagram showing a displacement-reaction force curve responsive to the relation between reaction force and displacement of a general fender.

10 Best Modes for Carrying Out the Invention

Fig. 1 is a diagram showing a schematic sectional structure of a fender according to a first embodiment of the present invention.

Referring to Fig. 1, the fender 11 is integrally formed by an elastic body such as rubber, a polymeric material consisting of polyurethane or the like having elasticity, or the like. More specifically, the fender 11 is formed by a discoid receiving part 13, a hollow truncated-conical first supporting part 15 connected to the receiving part 13 to outwardly spread from the outer peripheral edge of the receiving part 13, a hollow truncated-conical second supporting part 16 connected to the first supporting part 15 to outwardly spread from the outer peripheral edge of the first supporting part 15 through a first step part 20 and a flange 18 connected to

the lower end of the second supporting part 16 through a cylindrical part for mounting the fender 11 in contact with a quay or the like.

5 A receiving member such as a receiving plate is mounted on the outer side of the receiving part 13 to be used, although this receiving member is not shown in Fig. 1.

The specific dimensions of the fender 11 are as follows:

10 Total Height $H = 814 \text{ mm}$

The inner peripheral wall of the fender 11 is formed by a bell-shaped portion closer to the receiving part 13, an inclined surface having an inclination θ_3 located upward through a second step part 21 and an inclined surface
15 having an inclination θ_4 located below the second step part 21.

Diameter D of Receiving Part 13 = 704 mm

Diameter B of Outer Edge of Flange 18 = 1200 mm

Inclination θ_1 of Outer Peripheral Wall of Second
20 Supporting Part 16 = 15°

Inclination θ_2 of Outer Peripheral Wall of First
Supporting Part 15 = 15°

Inclination θ_3 of Upper Inner Peripheral Wall = 7.3°

Inclination θ_4 of Lower Inner Peripheral Wall = 7.9°

25 In the fender 11 having such dimensions, reaction

force and displacement caused when varying the inclination θ_1 of the outer peripheral wall of the second supporting part 16 were measured.

Fig. 2 shows displacement-reaction force curves
5 obtained in this manner.

Referring to Fig. 2, samples having five types of values 10° , 12.5° , 15° , 17.5° and 20° as to the inclination θ_1 of the second supporting part 16 were prepared in measurement for performing experiments. Consequently, the
10 following results were obtained as to the inclination θ_1 and the displacement:

	Inclination θ_1 of Second Supporting Part 16 ($^\circ$)	Displacement (%)
	10	53
15	12.5	62
	15	70
	17.5	70
	20	63

It has been proved from the aforementioned
20 experimental results that a preferable inclination θ_1 of the second supporting part 16 is 15° to 17.5° for setting the displacement to 70 % in the fender 11 shown in Fig. 1.

Fig. 3 is a diagram showing displacement-reaction force curves obtained by varying only the inclination θ_3 of
25 the upper inner peripheral wall in the fender 11 having

the prescribed dimensions shown in Fig. 1.

Fig. 3 shows curves obtained by preparing samples of the fender 11 by varying the inclination θ_1 to 7.3° and 15° respectively. While the displacement is identically 70 %
5 at both angles according to these curves, reaction force at the inclination of 7.3° is 1.3 P assuming that P represents the reaction force at the inclination of 15° . Therefore, it follows that the sample prepared by setting the inclination θ_1 of the inner peripheral wall to 7.3°
10 more effectively exhibits absorbed energy.

Fig. 4 is a diagram showing a schematic sectional shape of a fender according to a second embodiment of the present invention.

Referring to Fig. 4, the fender 11 is integrally
15 formed by an elastic body such as rubber, similarly to the aforementioned embodiment. More specifically, the fender 11 is formed by a discoid receiving part 13, a hollow truncated-conical first supporting part 15 connected to the receiving part 13 to outwardly spread through a third
20 step part 23 horizontally and outwardly extending from the outer peripheral edge of the receiving part 13, a hollow truncated-conical second supporting part 16 connected to the first supporting part 15 to outwardly spread from the outer peripheral edge of the first supporting part 15
25 through a first step part 20 and a flange 18 connected to

the lower end of the second supporting part 16 through a cylindrical part for mounting the fender 11 in contact with a quay or the like. The inner peripheral wall of the fender 11 is formed by a part, closer to the receiving
5 part 13, padded in the form of a bell, a part, located above the second step part 21, having an inclination θ_3 , and a part, located below the second step part 21, having an inclination θ_4 .

The fender 11 according to this embodiment is
10 basically identical in shape to the fender according to the aforementioned embodiment except the point that the third step part 23 is formed on the boundary between the receiving part 13 and the first supporting part 15 and the padded part located above the inner peripheral wall. The
15 inclination θ_1 of the second supporting part 16 is 15° , the inclination θ_2 of the first supporting part 15 is 7.3° , the inclination θ_3 of the upper part of the inner peripheral wall is 7.3° , and the inclination θ_4 of the lower inner peripheral wall is 7.9° . In other words, the thicknesses
20 are increased in the shapes of the first supporting part 15 and the second supporting part 16 with respect to those of the fender according to the aforementioned embodiment by the horizontal length A of the third step part 23. Except the dimensions related to the thicknesses thereof
25 and the upper dimension of the inner peripheral wall,

therefore, the remaining dimensions are identical to those of the fender according to the aforementioned embodiment.

In this embodiment, samples were prepared by varying the ratio of the horizontal length A of the third step part 23 to the diameter D of the receiving part 13 to 0.00 % (with no third step part 23), 0.04 %, 0.08 %, 0.11 %, 0.15 % and 0.19 % for experimentally obtaining displacement-reaction force curves.

Fig. 5 is a diagram showing the displacement-reaction force curves expressing the experimental results.

The experimental results were as follows:

A/D × 100 %	Displacement (%)
0.00	70
0.04	70
0.08	unsuitable to fender
0.11	unsuitable to fender
0.15	unsuitable to fender
0.19	unsuitable to fender

It has been proved from the aforementioned experimental results that the ratio of the horizontal length A of the third step part 23 to the diameter D of the receiving part 13 is preferably set in the range of 0 to 0.04 %.

While not shown in each of the aforementioned embodiments, low-frictional layers consisting of

polyurethane or polyethylene may be provided on the overall surfaces of the receiving part and the supporting part, whereby the fender can be prevented from deformation along the traveling direction of the hull when the hull comes into contact with the fender for attaining an efficient buffering effect by applying a load only in a compressive direction.

The reaction force following compression of the fender can be further improved when coming into contact with the hull by embedding reinforcing cloth in the fender, although the same is not shown in each of the aforementioned embodiments. Nylon woven fabric, glass mesh, metal mesh or the like may be employed as the reinforcing cloth.

Although the present invention has been described and illustrated in detail, it is clearly understood that the same is by way of illustration and example only and is not to be taken by way of limitation, the spirit and scope of the present invention being limited only by the terms of the appended claims.

Industrial Availability

As hereinabove described, the fender according to the present invention is suitable to a fender, employed as a buffer when a ship or the like comes alongside the quay or

moors at the quay, which is required to increase absorbed energy.

C L A I M S

1. A fender for ship integrally formed by an elastic body such as rubber, comprising:

5 a discoid receiving part;

a hollow truncated-conical first supporting part connected to said receiving part to outwardly spread from the outer peripheral edge of said receiving part; and

10 a hollow truncated-conical second supporting part connected to said first supporting part to outwardly spread from the outer peripheral edge of said first supporting part through a first step part, wherein

the inner peripheral walls of said first supporting part and said second supporting part have second step parts outwardly spreading in said second supporting part, and

15 the inclination of the outer peripheral wall of said first supporting part is 15° while the inclination of the outer peripheral wall of said second supporting part is 15 to 17.5°.

2. A fender for ship integrally formed by an elastic body such as rubber, comprising:

a discoid receiving part;

25 a hollow truncated-conical first supporting part

connected to said receiving part to outwardly spread from the outer peripheral edge of said receiving part; and

a hollow truncated-conical second supporting part connected to said first supporting part to outwardly spread from the outer peripheral edge of said first supporting part through a first step part, wherein

the inner peripheral walls of said first supporting part and said second supporting part have second step parts outwardly spreading in said second supporting part,

said first supporting part is connected through a third step part horizontally and outwardly extending from the outer peripheral edge of said receiving part,

the inclination of the outer peripheral wall of said first supporting part is 15° while the inclination of the outer peripheral wall of said second supporting part is 15° , and

the ratio of the horizontal length A of said third step part to the diameter D of said receiving part is 0 to 0.04 %.

3. The fender for ship according to claim 1 or 2, wherein the inclination of said inner peripheral walls closer to said receiving part is 7.3° with respect to said second step parts.