

OFFSHORE BOAT LANDING FENDER

Field of the Invention

The present invention provides an offshore boat landing fender for use in an offshore platform, an assembly containing fender and a bracket, and a landing platform for receiving
5 such a fender or assembly.

Background of the Invention

A fender is used on boat landing that attached to an offshore platform, to absorb the incoming impact of a crew boat during personnel transfer. Commonly used fenders are rub strips, rubber tyres, or grouted members. These conventional boat landing fenders are either very
10 weak at resisting side impact and vertical movement of the boat, or weak connection design. A damaged fender will subsequently cause damage to the boat landing structural framing and the boat itself, causing a safety hazard to personnel as well as disrupting operational activities. Therefore, there is a need for an improved boat landing fender that overcomes the above problems.

15 Summary of the Invention

In a first aspect, the invention provides a boat landing fender assembly for mounting to a landing platform, the assembly comprising: a fender unit, said fender unit having a compressible layer intermediate a first and second rigid plate; a bracket for mounting to the landing platform, said bracket connected to the fender unit on a first surface of the first rigid
20 surface; wherein, on mounting to the landing platform, a second surface of the second rigid plate is directed outwards from the landing platform.

In general, the invention may include a modular fender system comprising an array of selectively removable fender assemblies.

The compressible body absorbs impact from the vessel. It may comprise of a rubber layer intermediate rigid plates which may be made of steel, or any stiff metal that provides high structural integrity and durability. This offshore boat landing fender may be used as a modular fender for easy installation and fast replacement of individual fenders.

In an embodiment, the resilient body and rigid plates may be encapsulated by a resilient material. This resilient material may be a polymer, such as natural rubber or a specially formulated rubber composition. This rubber coating prevents the steel plates from corrosion from seawater or other environmental damage. In this embodiment, the first and second surfaces would refer to the corresponding surfaces of the resilient material.

In an embodiment, the fender may further comprise a pad attachable to the second surface for contacting the vessel. The pad may be made of an elastic polymer, such as ultra-high molecular weight polyethylene (UHMWPE) or high-density polyethylene (HDPE). The pad may be cut to the size of the rubber fender or metal plate. This pad provides a frontal layer with coefficient of friction below 0.2 for all direction of impacts. Thus, most of the impact force is transferred to the rubber fender for absorption, instead of tearing the rubber fender sideways. Edges of the pad may be chamfered for avoid side rotation due to angular frontal impact.

Since a fender may be used in a modular array of fenders, the assembly may comprise fenders of different sizes to accommodate the dimensions of frame portions. The brackets may be made of the same size for easy installation and backup storage. Each fender may be

attachable to one or more brackets, and each bracket may be attachable to one or more fenders.

In an embodiment, the brackets may be arranged to position fenders adjacently on a planar surface. This design ensures that the landing frame is protected in its entirety despite a
5 vessel's movement, while also facilitating efficient load transfer and absorption between adjacent fenders.

In an embodiment, the brackets may be adjustable to position the fenders flush on a planar level to absorb incoming impact evenly. This ensures that all fenders have equal possibility in absorbing an incoming force and eliminating a potential weakest link, where damage to the
10 boat hull or fender may result.

In an embodiment, the assembly may further comprise at least one compressible member at a contact point between the bracket and the platform. The compressible member may be a polymer pad, such as a neoprene pad. The neoprene layer may be compressed at 50% of its original thickness at final assembly. The compressible layer protects the surface of the
15 landing frame, and increases the friction force by the clamp units. The friction force applied will be able to sustain the assembled boat landing fender in position, avoid slipping due to gravity effect on its own weight or rotate horizontally due to angular impact by an approaching vessel.

The above fender assembly allows fast and easy installation and repair. Therefore, the
20 landing platform using the above fender or fender assembly would provide minimal downtime for maintenance, and lower maintenance and repair costs.

Brief Description of the Figures

It will be convenient to further describe the present invention with respect to the accompanying drawings that illustrate possible arrangements of the invention. Other arrangements of the invention are possible and consequently, the particularity of the accompanying drawings is not to be understood as superseding the generality of the preceding description of the invention.

Figures 1A and 1B are perspective views of a boat fender assembly according to one embodiment of the present invention.

Figure 2 is a side elevation of rubber fender according to a further embodiment of the present invention.

Figure 3 is a perspective view of a HDPE fender pad according to one embodiment of the present invention.

Figures 4A and 4B are elevation views of a fender assembly, mounted to a landing platform member, according to one embodiment of the present invention.

Figures 5A and 5B are elevation views of a landing platform, having an array of fender assemblies mounted thereto, according to a further embodiment of the present invention.

Figure 6 is a plan view of the landing platform of Figure 5.

Figures 7A and 7B are perspective views of a fender assembly mounting according to one embodiment of the present invention.

Figures 8A and 8B are elevation side views of fender assemblies according to still further embodiments of the present invention.

Detailed Description of the Invention

The invention provides a modular system for offshore boat landing fender. In general terms, a plurality of fender assemblies are mountable to a landing platform, with each fender assembly having one or more fender units. When mounted, the fender units form an array which, together, provide protection to the landing platform. The array of fender units may be mounted to as to form a flush contact plane against which a vessel may impact. In so doing, the vessel will contact several of the fender units simultaneous, giving the mechanical performance of a larger single fender, and by better distributing the load to the landing platform.

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A particular advantage of having an array of smaller fender units includes the modularity benefit. If a fender unit within the array is damaged, it can be readily replaced, as compared to conventional fender systems having single fender weighing several tons.

15 Further, the total weight of the fender system can be optimised for the application. Conventional fender systems require massive (several tons) fenders, and so different fender systems need to be employed for different applications. However, different fender systems may provide different mechanical protection. Smaller fender system may be designed assuming smaller vessels, however, this may not be the case. A landing platform for a regional port may have a much smaller landing platform, but still require protection from container vessels having the potential to cause substantial damage. The modular arrangement of a fender system according to the present invention allows for landing platforms which may

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be smaller. A smaller fender system according to the present invention can be modified by using fewer fender units, but still reflecting the mechanical resistance of a larger system.

Further still, having an array of smaller fender assemblies allows for each part of the landing platform to have a fender assembly mounted thereto. If a greater portion of the landing platform is connected to a fender assembly, then this more closely models a uniformly distributed load. With conventional fenders, because of their size, the fenders will span across members rather than be mounted at more frequent positions, and so they model a series of point loads rather than the more efficient uniformly distributed load. Therefore, the landing platform becomes a more efficient load bearing system purely by using a fender system according to the present invention.

Turning to the embodiments of Figures 1A, 1B, 2 and 3, these show a fender assembly according one embodiment of the present invention. The fender assembly 5 includes a rubber fender unit 45 which includes a compressible layer, such as an intermediate rubber layer 55, as primary impact absorber, to resist the impact of a vessel, when mounted to a landing platform. In one illustrative example, this intermediate rubber layer 55 may absorb up to 50 kJ. The rubber fender unit 45 further includes two rigid plates 50A, 50B between which is placed the intermediate rubber layer 55. The connection of the intermediate rubber layer 55 to the rigid plates 50A, 50B may include a chamfered portion 60, which may assist in distributing concentrated loading during deformation. The rubber fender unit 45 has a first surface 52 for attaching to a landing platform and a second surface 54 to be positioned on a seaward side, and for contacting an incoming vessel. In this instance, the first surface 52 is

located on the first rigid (steel) plate 50A, and the second surface 54 is located on the second rigid (steel) plate 50B. Cumulatively, the second surface of all the fender units may be arranged into a flush contact plane as the fender assemblies are mounted to the landing platform in an array. Thus, the array of fender assemblies creates the flush contact plane
5 against which a vessel may impact.

The fender assembly 5 comprises the rubber fender unit 45 coupled to a metal bracket 20 on the first surface 52, with the bracket 20 arranged to clamp to the landing platform (not shown). In this embodiment, the landing platform is arranged to comprise a cylindrical tubular structure, and so the bracket is arranged to clamp around the cylindrical members
10 using bolted portions 25, 30. It will be appreciated that the bracket 20 may be modified to engage different types of landing platform, so as to achieve the required load transfer between the fender assembly and the landing platform. In this example, the metal bracket is a steel bracket, structurally designed to withstand a minimum of 110 kJ/m impact force and utilizes a clamping concept for easy and user-friendly installation. A neoprene layer 27 may be
15 positioned between the steel bracket 20 and the frame portion. The bracket 20 may also include anti-rotation portions 35, 40 providing a bearing load to a cross-member of the landing platform when the fender assembly is impacted eccentrically.

In this embodiment, the fender assembly 5 includes three fender units 15A to 15C mounted to a single bracket, each having a fender pad 10A to 10C bolted. Thus, it can be shown that the
20 modular fender units may also be modular within the fender assembly 5.

In a further embodiment, a pad, or low friction HDPE pad 65, may be mounted to the second surface 54. The HDPE pad 65 may be made of a suitable polymer, such as HDPE or UHMWPE. This HDPE pad 65 bears the frontal impact force from an approaching vessel,

and provides a low-friction surface so that the incoming impact energy is transferred to the rubber fender, without the additional load of a frictional engagement between the vessel and fender. With the use of the low friction pad/plate, instead of the second surfaces of the fender units within the array forming the flush contact plane, instead, the low friction pads/plates
5 form a flush low friction contact plane

Figures 4A and 4B show a landing platform 95 having vertical 85 and horizontal 90 members. Fender assemblies 75 are mounted on vertical members 85. Multiple fenders 75 may be attached to the frame via one or more brackets 80A, 80B. The fender assembly according to one embodiment may be an integration of three main components:

- 10 a. A front plate: frontal impact surface, delivering low-friction surface to ensure the incoming impact energy is directly transfer to the rubber fender unit, and using materials such as HDPE;
- b. Fender unit: The primary impact cushioning body arranged for energy absorption up to, say, 50 kJ. Natural Rubber may be a suitable material;
- 15 c. Bracket: Arranged to withstand up to, say, 110 kJ/m impact force. It may couple to a landing platform using a clamping arrangement for user-friendly installation.

By way of example, the mechanical performance of a fender unit corresponded to 50 kN.m energy respond target yielding about 27% compression when the rubber hardness is formulated to 74° and there is no surface crack found on the rubber material.

20 In a still further embodiment, and provided as an example only, the specification for a fender system according to the present invention may be defined as follows:

- a. The fender system may resist minimal energy under the following conditions:

- Single member impact: 50 kJ/meter (material); or
 - 110 kJ/meter with boat landing structural members (mild-steel) combined
- b. The fender system, using a fender pad, may have a coefficient of friction below 0.2 for all direction of impact.
- 5 c. For any design with fender installed in front of the boat landing, the total extending length (the centreline of boat landings tubular members to outer edge of fender) may be less than 400mm, to allow safe personnel boat transfer with swing rope.
- d. Increase of overall wave load to boat landing structure may be less than 10% with proposed fender system.
- 10 e. Increase of overall weight of boat landing structure may be less than 10% with proposed fender system. For example, the target specification may be set to < 7,000 kg of additional weight.
- f. The fender system may remain intact after impact especially the connection

In fulfilling these requirements, the fender system may involve an implementation with 3
15 primary components (metal bracket, fender unit and HDPE pad) which may be flexible to the other Boat Landing design with rub strip.

To provide context to the invention, the following possible dimensions are provided as an illustrative example only. To this end, the fender unit may have a form factor of:

- Length x Width x Height: 450 mm x 450 mm x 130 mm
- 20 • Weight: 60 kg

In forming a full fender system, the system may include between 24 and 36 fender units, having various arrangements of bracket mounting to the landing platform.

Each fender unit may have top and bottom metal flanges made of 16mm steel plates fully embedded in rubber with thickness of ~6mm. This rubber coating prevents steel plates from
5 environmental exposures especially avoiding corrosion.

A fender unit, according to one embodiment of the present invention may be formulated with rubber hardness to 74° has yielded 52.1 kN.m at 27% compression to product height (35mm height reduction).

Frontal impact towards the fender may be received by a high-molecular-weight polyethylene
10 (HDPE) face pads, cut to the size of the fender metal flanges. Edges of the HDPE pad (as shown in Figure 3) may be chamfered for avoiding side rotation due to angular frontal impact. The primary property of HDPE pad may provide a frontal layer with coefficient of friction below 0.2 for all direction of impacts. In this case, frontal impacts may be predominantly transferred to the absorption of rubber fender, rather than applying friction induced shear
15 forces to the intermediate rubber layer.

The HDPE face pad form factor may be arranged to fit the second face of the fender unit to ensure coverage. End portions may be rounded to prevent an interference contact with the vessel. Based upon the exemplary dimensions for the fender unit mentioned above, the following dimensions may be considered as a non-limiting guide:

- 20
- Length x Width x Height: 450 mm x 450 mm x 40 mm
 - Weight: 0.7 kg

The HDPE pad may be held to the fender unit via bolts and nuts and fully flushed within the HDPE pad to avoid metal bolt shearing the incoming vessel's metal hull. Bolts and nuts installation allowing easy individual unit replacement from wear and tear of collision by incoming vessel's metal hull.

- 5 The HDPE pad is pre-manufactured to size with the plate units yielding a coefficient of friction of approximately 0.2, and possibly below 0.2.

Figures 5A, 5B, 6, 7A, 7B, 8A and 8B show various embodiments of the fender assemblies mounted to the boat landing. The attachment may involve using a clamp system to support easy installation.

- 10 Figures 5A and 5B, in particular, demonstrate the “array mounting” feature of the invention, whereby the fender assemblies 75 are mounted at numerous points along the vertical members 95. In so doing, the array 100 of fender assemblies more closely model a uniformly distributed load. It will be appreciated that the horizontal members may also receive fender assemblies, though the chance of different water heights leading to a “snag” of a vessel to an
- 15 upper edge of a horizontal fender assembly may weigh against such an approach. Nevertheless, such an arrangement may still fall within the present invention, and be useful for applications where water height and wave activity is less volatile, such as for lakes and reservoirs.

- 20 Figures 6, 7A and 7B show various mounting options, such as:

- i) Providing a direct contact 110 between the fender unit and an underlying vertical member to which it is mounted to further enhance the load transfer;
- ii) Providing a gap 105 between the fender unit and a horizontal member 90 to ensure load transfer is through the vertical members only;
- 5 iii) Having the fender units, or fender pads, flush 115 with each other on a seaward side so that the “array” mounting receives the vessel impact uniformly;

As mentioned previously, the fender assemblies may include a minimal contact with the horizontal members 90 through anti-rotational pads 120 at a top of the fender assembly and at the bottom 140A and 140B. This contact may be passive and arranged to act as a ‘stop’ to
10 prevent rotation of the fender assembly should a vessel contact the fender assembly eccentrically.

Figures 8A and 8B show elevation side views of fender assemblies according to the present invention, with a two-bracket fender assembly 145 having two brackets 155A, 155B attached
15 to four fender units 160A to 160E. By contrast, a smaller one-bracket fender assembly 150 may also be used where a single bracket 165 may attach to two fender units 170A, 170B. These examples show that various combinations of brackets and fender units may be possible, with an array having several different combinations within the array. Which combinations may be a function of several factors, including but not limited to: the loading platform size,
20 loading platform member size, and the vessel contact area to be protected.

Importantly, as the various forms of the fender assemblies are mountable to a landing platform, individual fender assemblies are also selectively removable from the array. Should a fender assembly within the array be damaged, it can be removed, repaired or replaced without impacting the overall function of the array. Prior art systems, because of the large and heavy fenders may require an entire landing platform to become unavailable should maintenance be required. Not so for this embodiment of the invention. As each fender assembly only forms a relatively small part of the overall array, the performance of the array may not be affected through the removal. Further, individual fender units may also be selectively removable from the array, with similar low impact on overall performance. It may be preferable to remove a fender assembly having a damaged fender unit. In this case, the fender assembly could be removed, the fender unit unbolted, and the fender assembly re-mounted to the landing platform. The whole process may, in certain circumstances, be a matter of hours.

The brackets may be positioned 50mm lowered than the landing platform to eliminate any possibility of tripping during safe swing. Figures 8A and 8B further show the plurality of fender assemblies attached to the interconnected members of the landing platform, in such a way so that the second surfaces, or the outer surface of the pads, are arranged in a co-planar arrangement to form a flush contact plane

The clamp may include a hinge to ease installation and fitted with bolts and nuts at each side of the bracket to ensure even force applied to the Boat Landing vertical members. The clamps may be positioned off-set to the horizontal members to allow potential mismatch at as-built drawing.

The metal bracket may use C-channels as a primary structure for impact distribution and transfer. While keeping the overall height within the design boundary, C-channel inherited challenges of lateral access.

The metal bracket clamps may be assembled with a neoprene layer, such as in the range 10 to 5 20mm, for protecting the surface of boat landing vertical member as well as increasing friction force by the clamp units (Figure 1A and 1B). The neoprene layer 27 may be compressible to 50% of its original thickness at final assembly. The friction force applied may be able to sustain the assembled rubber fender in-positioned, avoid slipping due to gravity effect on its own weight or rotated horizontally due to angular impact by approaching 10 vessel.

CLAIMS

1. A boat landing fender assembly for mounting to a landing platform, the assembly comprising:

a fender unit, said fender unit having a compressible layer intermediate a first and
5 second rigid plate;

a bracket for mounting to the landing platform, said bracket connected to the fender unit on a first surface of the first rigid surface;

wherein, on mounting to the landing platform, a second surface of the second rigid plate is directed outwards from the landing platform.
- 10 2. The assembly according to claim 1, further comprising a pad attachable to the second surface, said pad arranged to receive an impact from a vessel.
3. The assembly according to claim 2, wherein the pad includes a polymer material.
4. The assembly according to any one of claims 1 to 3, further including a plurality of fender units attached to said bracket, said plurality of fender units arranged to have
15 respective second surfaces in a co-planar arrangement.
5. The assembly according to any one of claims 1 to 3, further including a plurality of fender units attached to a plurality of brackets, said plurality of fender units arranged to have respective second surfaces in a co-planar arrangement.
6. An array of boat landing fender assemblies, for mounting to a landing platform,
20 comprising a plurality of boat landing fender assembly according to any one of claims 1 to 5.

7. The array of boat landing fender assemblies according to claim 6, wherein co-planar arrangement forms a flush contact plane for receiving an impact from a vessel.
8. The array of boat landing fender assemblies according to claim 6 or 7, wherein individual fender assemblies are selectively removable from the array.
- 5 9. The array of boat landing fender assemblies according to any one of claims 6 to 8, wherein individual fender units are selectively removable from the array.