ANTI-COLLISION DEVICE MADE OF BUFFERING ENERGY-ABSORBING TYPE WEB-ENHANCED COMPOSITE MATERIAL

Inventors: Weiqing Liu, Nanjing (CN); Hai Fang, Nanjing (CN); Lu Zhu, Nanjing (CN); Weidong Lu, Nanjing (CN)

Assignees: NANJING UNIVERSITY OF TECHNOLOGY, Nanjing, Jiangsu (CN); JIANGSU BOHONG NEW MATERIALS TECHNOLOGY CO., LTD, Changzhou, Jiangsu (CN)

An anti-collision device made of a buffering energy-absorbing type web-enhanced composite material, including an anti-collision unit. The anti-collision unit includes a housing and a filling material body located in the housing, and the housing is a solid housing formed of a composite material surface layer or a sandwiched housing formed of a composite material surface layer internally filled with a sandwiched material, and the sandwiched material; the filling material body includes a space lattice body and an energy consuming material, the space lattice body is formed of fiber webs arranged in the housing in a single-layered unidirectional, single-layered bidirectional, multi-layered unidirectional or multi-layered multi-directional manner, and the energy consuming material is located between the fiber webs and/or between the fiber webs and inner walls of the housing.
FIG. 3
FIG. 8
ANTI-COLLISION DEVICE MADE OF BUFFERING ENERGY-ABSORBING TYPE WEB-ENHANCED COMPOSITE MATERIAL

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a bridge or dock anti-collision structure in particular, to a low-cost and green anti-collision device made of a composite material, and specifically to an anti-collision device made of a buffering energy-absorbing type web-enhanced composite material, which is applicable to piers, bridge towers, and bearing platforms of various bridges, docks, waterfront buildings, seaborne buildings and ships and used for alleviating a collision disaster from a ship, a floating ice or a vehicle.

[0003] 2. Related Art

[0004] It is well-known that, accidents of collision between a ship (vehicle) and a bridge continuously occur around the world all the time, and the frequency of accidents of collision between a ship and a bridge is far higher than our imagination. Casualties, property loss and environment damage caused by accidents of collision between a ship and a bridge are amazing. Many accidents of collision between a ship and a bridge at least lose tens of thousands of dollars, more seriously, casualties occur, and the loss amounts to millions, tens of millions or even billions of dollars; it is more difficult to calculate enormous indirect loss. Therefore, it is especially necessary to take an anti-collision measure for a bridge, whose fundamental objective is to prevent the structure of the bridge from being damaged due to a ship (vehicle) collision force, and meanwhile to protect the ship (vehicle) as much as possible to reduce the loss to the lowest extent.

[0005] Over years of research and application, multiple pier anti-collision facilities for collision between a ship and a bridge occur home and abroad, but the basic principle thereof is designed based on energy absorbing and momentum buff ering, and each facility has its own characteristic and use condition. Specifically, the anti-collision facilities may be divided into two types. One type is the indirect type, characterized in that in addition to a pier, an anti-collision facility is additionally arranged, and the pier is not directly subject to a force, to enable the pier to thoroughly avoid the ship collision problem. For example, the pile group manner, the thin-shell sand-building cofferdam manner, and the man-made island manner are generally applicable to an occasion where water is shallow and the geology condition is good. The anti-collision method of the indirect type is done once for all, but the shipping lane may be affected, and usually the indirect type is abandoned since the manufacturing cost is excessively high or the condition is not met. The other type is the direct type, characterized in that: a force is buffered and then directly applied on the pier, such as in a fender manner, a rope deformation manner, a buffering material facility manner, a buffering facility engineering manner and a manner of a fixed or floating casing box anti-collision facility. Generally the direct type is used in an occasion where the shipping lane is narrow and water is deep. Generally the fabrication expenses are economic, and the civil engineering quantity is not large. For example, a steel box type anti-collision device is adopted for Zhujiang Bridge and Shanghai Yangtze River Bridge, the energy dissipation facility utilizes plastic deformation and damage of steel products for energy dissipation. When a ship collides with the steel casing box anti-collision device, large deformation occurs in a steel plate in a discontinuous (intermittent) structure of the outer layer of the anti-collision structure, part of collision energy is absorbed, and contact time is prolonged, so that the peak value of the collision force is reduced. Meanwhile, due to structure deformation and mutual action, the direction of the prow is changed, and energy exchange between the ship and the structure is reduced. However, the steel casing box generally bears collision once, repair is difficult after the steel casing box is damaged due to the collision; meanwhile, during collision, the ship body is susceptible to damage: additionally, the steel products are easily rusted in water over years, and maintenance expenses are high, so it is extremely urgent to design and develop an innovative anti-collision system made of a new material.

SUMMARY OF THE INVENTION

[0006] The objective of the present invention is to provide an anti-collision device made of a buffering energy-absorbing type web-enhanced composite material which may fully absorb collision energy, and be low in cost, wide in application range, green and environment friendly to solve the problem of the existing bridge anti-collision device that the anti-collision effect is bad, the cost is high or the repair difficulty is large.

[0007] The objective of the present invention is achieved through the following technical solution.

[0008] An anti-collision device made of a buffering energy-absorbing type web-enhanced composite material includes an anti-collision unit 1, where the anti-collision unit 1 includes a housing 2 and a filling material body 3 located in the housing 2, and the housing 2 is a solid housing formed of a composite material surface layer 4 or a sandwiched housing formed of the composite material surface layer 4 internally filled with a sandwiched material 5, and the sandwiched material 5; the filling material body 3 includes a space lattice body 6 and an energy consuming material 7, the space lattice body 6 is formed of fiber webs 8 arranged in the housing 2 in a single-layered unidirectional, single-layered bidirectional, multi-layered unidirectional or multi-layered multi-directional manner, and the energy consuming material 7 is located between the fiber webs 8 and/or between the fiber webs 8 and inner walls of the housing 2.

[0009] Any two anti-collision units 1 adjacent and connected to each other are connected through a connection member 9 between each other.

[0010] The connection member 9 is one of or a combination of several of a cable, a stainless steel chain, a mooring rope, a steel strand, a bolt, a nylon stick and a dowel pin.

[0011] A side of the anti-collision unit 1 is provided with anti-collision buffering facilities 10, the anti-collision buffering facilities 10 are arranged at an inner side of the anti-collision unit 1 through fasteners 11 at an interval, and the anti-collision buffering facility 10 is made of a rubber fender or an anti-collision bag internally provided with the filling material body 3.

[0012] The composite material surface layer 4 is made of fiber and resin, where the fiber is at least one of carbon fiber, glass fiber, basalt fiber, aramid fiber, and hybrid fiber, the resin is at least one of unsaturated polyester, phthalic resin, vinyl resin, epoxy resin, inorganic resin and a thermoplastic resin material.
The sandwiched material 5 is at least one of polyurethane foam, polyvinyl chloride foam, carbon foam, PEI foam, PMT foam, Balsa wood, paulownia wood, China fir and strong core felt.

The energy consuming material 7 is at least one of polyurethane foam, polyvinyl chloride foam, carbon foam, PEI foam, PMT foam, Balsa wood, paulownia wood, China fir, foam aluminum, foam sand, cellular, round pipe, Mao bamboo, rubber tyre, rubber particles, rubber block, polyurethane elastomer, sand, a mixture of foam particles and sand, polyphenyl mortar, hollow pipe, and hollow plastic ball.

The anti-collision unit 1 is strip-shaped, block-shaped, rounded, elliptical, arc-shaped, in a shape of figure “7”, ring-shaped, or box-shaped.

Compared with the prior art, the present invention has the following advantages.

1. In the present invention, independent anti-collision units may be rapidly connected as a whole through a connection member, and replacement of a single damaged unit is convenient and rapid.

2. In the present invention, the filling material body resists collision and consumes energy by filling the energy consuming material in the space lattice body; vertically and horizontally staggered fiber webs has high shear resisting strength and certain buffering elastic deformation capability, the housing made of a composite material may be protected from large shear deformation, and the energy consuming material between the fiber webs may enhance local instability resistance of the fiber webs, so that the energy consuming structure in a space lattice shape formed of the fiber webs and the energy consuming material comes into play, thereby reducing the loss caused by collision between a ship or vehicle and a bridge; meanwhile, the adopted energy consuming material is a green recycle material which may provide buffering after compression and absorb energy, so the whole energy-absorbing effect thereof is good, and the manufacturing cost is low.

3. In the present invention, the housing of the anti-collision unit is made of a resin based fiber enhanced composite material, whose corrosion resistance performance is extremely superior, whose service life may be up to over 50 years, and which may endure corrosion of various hostile environments such as river water and sea water for a long time; and the adopted fiber is long fiber which may effectively disperse a collision load with a large contact area quickly.

4. In the present invention, the anti-collision device is good in the elastic performance, may be self-floating or fixed, and may be widely applied to the field of piers, bridge towers, and bearing platforms of various bridges, docks, waterborne buildings, seaborne buildings and ships and used for alleviating a collision disaster from a ship, a floating ice or a vehicle; after collision from a ship, floating ice or vehicle occurs, collision time of the ship, floating ice or vehicle is prolonged, and the ship collision force is reduced through buffering and energy dissipation, so that no local damage occurs in the protected structure, and the ship, the vehicle and the personnel safety may be effectively protected.

5. In the present invention, the size and the appearance of the anti-collision device are not limited, the designability is strong, the manufacturing cost is moderate, the anti-collision function is reliable and faultless, the service life is long, and maintenance and repair are convenient.

**BRIEF DESCRIPTION OF THE DRAWINGS**

**FIG. 1** is a schematic structural diagram of the present invention;

**FIG. 2** is a schematic diagram of an internal structure of an anti-collision unit of the present invention;

**FIG. 3** is a schematic diagram of a combination form of a space lattice body of the present invention, where **FIG. 3 (a)** is a schematic structural diagram of single-layered unidirectional arrangement of a lattice web, **FIG. 3 (b)** is a schematic structural diagram of single-layered bidirectional arrangement of a lattice web, **FIG. 3 (c)** is a schematic structural diagram of double-layered unidirectional arrangement of a lattice web, and **FIG. 3 (d)** is a schematic structural diagram of multi-layered multi-directional arrangement of a lattice web;

**FIG. 4** is a first schematic structural diagram in which an anti-collision device of the present invention is arranged at an outer side of a bridge bearing platform;

**FIG. 5** is a second schematic structural diagram in which an anti-collision device of the present invention is arranged at an outer side of a bridge bearing platform;

**FIG. 6** is a third schematic structural diagram in which an anti-collision device of the present invention is arranged at an outer side of a bridge bearing platform;

**FIG. 7** is a fourth schematic structural diagram in which an anti-collision device of the present invention is arranged at an outer side of a bridge bearing platform;

**FIG. 8** is a top view of a structure at a location where an anti-collision unit is arranged in **FIG. 7**;

**FIG. 9** is a schematic structural diagram in which an anti-collision device of the present invention is arranged at a port dock;

**FIG. 10** is a schematic structural diagram in which an anti-collision device of the present invention is arranged on a beam of an urban flyover;

**FIG. 11** is a schematic structural diagram in which an anti-collision device of the present invention is arranged on a pier; and

**FIG. 12** is a top view of **FIG. 10**.

1. anti-collision unit; 2. housing; 3. filling material body; 4. composite material surface layer; 5. sandwiched material; 6. space lattice body; 7. energy consuming material; 8. fiber web; 9. connection member; 10. anti-collision buffering facility; 11. fastener

**DETAILED DESCRIPTION OF THE INVENTION**

The present invention is further illustrated below with reference to accompanying drawings and embodiments. As shown in **FIG. 1** to **FIG. 3**, an anti-collision device made of a buffering energy-absorbing type web-enhanced composite material includes an anti-collision unit 1, and the anti-collision unit 1 includes a housing 2 and a filling material body 3 located in the housing 2, where the housing 2 is a solid housing formed of a composite material surface layer 4 or a sandwiched housing formed of a composite material surface layer 4 internally filled with a sandwiched material 5, and the sandwiched material 5, the composite material surface layer 4 is made of fiber and resin, the fiber is selected from at least one of carbon fiber, glass fiber, basalt fiber, aramid fiber, and hybrid fiber, and the resin is selected from at least one of unsaturated polyester, phthalic resin, vinyl resin, epoxy resin, inorganic resin and a thermoplastic resin material; the sandwiched material 5 is at least one of polyurethane
foam, polyvinyl chloride foam, carbon foam, PEI foam, PMI foam, Balsa wood, paulownia wood, China fir and strong core felt. The filling material body 3 includes a space lattice body 6 and an energy consuming material 7, the space lattice body 6 is formed of fiber webs 8 arranged in the housing 2 in a single-layered unidirectional, single-layered bidirectional, multi-layered unidirectional or multi-layered multi-directional manner, and the included angle between the fiber webs 8 is selected randomly, but the fiber webs are preferably orthogonally arranged; the energy consuming material 7 is located between the fiber webs 8 and/or between the fiber webs 8 and inner walls of the housing 2, the energy consuming material 7 is selected from at least one of polyurethane foam, polyvinyl chloride foam, carbon foam, PEI foam, PMI foam, Balsa wood, paulownia wood, China fir, foam aluminum, foam sand, cellular, round pipe, Mao bamboo, rubber tire, rubber particles, rubber block, polyurethane elastomer, sand, a mixture of foam particles and sand, polyphenyl molar, hollow pipe, and hollow plastic ball, and the size, the number, and the location of the energy consuming material 7 may be flexibly adopted according to the actual force applied to the structure. The filling material body 3 may be formed in a manner of forming the space lattice body 6 in advance by adopting the fiber webs 8 and then filling the space lattice body 6 with the energy consuming material 7, or formed in a manner of adopting the fiber webs 8, the energy consuming material 7 and the housing 2 simultaneously. Additionally, in order to further enhance the performance of the anti-collision unit 1, anti-collision buffering facilities 10 may be arranged at a side of the anti-collision unit 1, the anti-collision buffering facilities 10 are arranged at an inner side of the anti-collision unit 1 at an interval through fasteners 11, and the anti-collision buffering facility 10 may be made of a rubber fender or an anti-collision bag internally provided with the filling material body 3. The anti-collision unit 1 is strip-shaped, block-shaped, rounded, elliptical, arc-shaped, in a shape of figure “7”, ring-shaped, or box-shaped or is in another shape matched with the appearance of the anti-collision target body. Any two anti-collision units 1 adjacent and connected to each other may be connected through a connection member 9 between each other, and the connection member 9 is one of or a combination of several of a cable, a stainless steel chain, a mooring rope, a steel strand, a bolt, a nylon stick and a dowel pin; the anti-collision unit 1 may further be directly fixed on the surface of the anti-collision object by use of a fastening connection member such as a bolt. Additionally, in order to ensure stability of the anti-collision unit 1, the anti-collision unit 1 may further be fixed on the anti-collision target body by use of the fastener 11.

**EMBODIMENT 2**

[0038] As shown in FIG. 5, an anti-collision device made of a buffering energy-absorbing type web-enhanced composite material is shown. The anti-collision device is in a ring-shaped fixed structure matched with the appearance of a bridge bearing platform, the ring-shaped structure is formed of several anti-collision units 1, the anti-collision unit 1 is formed of a housing 2 and a filling material body 3 filled in the housing 2, and the housing 2 with an arc-shaped cross section is formed of a composite material surface layer 4 formed by solidifying glass fiber and vinyl resin; an energy consuming material 7 in the housing 2 is selected from polyurethane foam, the outside of the polyurethane foam is wrapped with biaxial glass fiber cloth, then the biaxial glass fiber cloth is laid in a multi-layered multi-directional manner to form a space lattice body 6 formed of fiber webs 8, and then the anti-collision unit 1 is integrally formed with a vacuum infusion process. After the anti-collision unit 1 is prepared in a factory, on an installation site, a bolt is used as a fastener 11 to install the anti-collision buffering facility 10 at an inner side of the anti-collision unit 1, and then a bolt is used as a connection member 9 to fixally connect with an adjacent anti-collision unit 1, so that the anti-collision device made of a buffering energy-absorbing type web-enhanced composite material matched with the periphery of the pier is formed.

**EMBODIMENT 3**

[0039] As shown in FIG. 6, an anti-collision device made of a buffering energy-absorbing type web-enhanced composite material is shown. The anti-collision device is in a ring-shaped fixed structure matched with the appearance of a bridge bearing platform, the ring-shaped structure is formed of several anti-collision units 1, the anti-collision unit 1 is formed of a housing 2 and a filling material body 3 filled in the housing 2, and the housing 2 with a cross section in a shape of figure “7” is a solid housing formed of a composite material surface layer 4 formed by solidifying glass fiber and vinyl resin; an energy consuming material 7 in the housing 2 is selected from polyurethane foam, the outside of the polyurethane foam is wrapped with glass fiber cloth in a direction of ±45°, then the glass fiber cloth is laid in a multi-layered multi-directional manner to form a space lattice body 6 formed of fiber webs 8, and then the anti-collision unit 1 is integrally formed with a vacuum infusion process. After the anti-collision unit 1 is prepared in a factory, on an installation site, the anti-collision unit 1 is hung on the concrete bridge bearing platform, and a bolt is used to fixally connect the anti-collision unit 1 and the outside of the bridge bearing platform. The number of and the arrangement manner of the anti-collision units 1 are designed according to function needs.
EMBODIMENT 4

[0040] As shown in FIG. 7 and FIG. 8, an anti-collision device made of a buffering energy-absorbing type web-enhanced composite material is shown. The anti-collision device is in a semi-ring-shaped fixed structure matched with the appearance of a bridge bearing platform, the semi-ring-shaped structure is formed of several anti-collision units 1, the anti-collision unit 1 is formed of a housing 2 and a filling material body 3 filled in the housing 2, the cross section of the housing 2 is box shaped and is provided with a chamfer, and the housing 2 is formed of a composite material surface layer 4 formed by solidifying basalt fiber and epoxy resin and a sandwiched material 5 filled in the composite material surface layer 4 and made of balsa wood; an energy consuming material 7 in the housing 2 is selected from transversely arranged Mao bamboo, and the transversely arranged Mao bamboo is filled in a cavity formed by a space lattice body 6. After the anti-collision unit 1 is prepared in a factory, on an installation site, a bolt is used as a connection member 9 to fix the anti-collision unit 1 at the outside of the bridge bearing platform along an impacted area of the bridge bearing platform. The number of and the arrangement manner of the anti-collision units 1 are designed according to function needs.

EMBODIMENT 5

[0041] As shown in FIG. 9, an anti-collision device made of a buffering energy-absorbing type web-enhanced composite material is shown. The anti-collision device is arranged on a port dock, the anti-collision device is formed of several anti-collision units 1, the anti-collision unit 1 is formed of a housing 2 and a filling material body 3 filled in the housing 2, the housing 2 with the cross section in a cylinder shape is formed of a composite material surface layer 4 formed by solidifying glass fiber and vinyl resin and a sandwiched material 5 filled in the composite material surface layer 4 and made of paulownia wood, and local filling holes are reserved; a space lattice body 6 is arranged in the housing 2 in advance, the housing 2 made of a composite material is integrally formed with a vacuum infusion process, then foam and is filled into the housing 2 to serve as an energy consuming material 7, and then hand lay-up is performed on glass steel to seal the filling holes, thereby forming the cylindrical anti-collision unit 1. After the anti-collision unit 1 is prepared in a factory, on an installation site, a bolt is used to fix the anti-collision unit 1 at the outside of the port dock along an impacted area of the port dock. The number of and the arrangement manner of the anti-collision units 1 are designed according to function needs.

EMBODIMENT 6

[0042] As shown in FIG. 10, an anti-collision device made of a buffering energy-absorbing type web-enhanced composite material is shown. The anti-collision device is arranged on a beam of an urban flyover, thereby preventing an urban ultra high vehicle from colliding with a main beam of a bridge to cause vehicle damage, casualties, and girder falling or even collapse of the bridge. An anti-collision unit 1 is formed of a housing 2 and a filling material body 3 filled in the housing 2, the cross section of the housing 2 is in a block shape, and the housing 2 is a solid housing formed of a composite material surface layer 4 formed by solidifying glass fiber and vinyl resin; an energy consuming material 7 in the housing 2 is selected from polyurethane foam, and then the anti-collision unit 1 is integrally formed with a vacuum infusion process. After the anti-collision unit 1 is prepared in a factory, on an installation site, the anti-collision unit 1 is transversely arranged along the beam of the urban flyover by use of a bolt. The number of and the arrangement manner of the anti-collision units 1 are designed according to function needs.

EMBODIMENT 7

[0043] As shown in FIG. 11 and FIG. 12, an anti-collision device made of a buffering energy-absorbing type web-enhanced composite material is shown. The anti-collision device is in a ring-shaped fixed structure matched with the appearance of a pier, the ring-shaped structure is formed of several anti-collision units 1, the anti-collision unit 1 is formed of a housing 2 and a filling material body 3 filled in the housing 2, and the housing 2 whose cross section is matched with the appearance of the pier is a solid housing formed of a composite material surface layer 4 formed by solidifying glass fiber and unsaturated polyester resin; the housing 2 is filled with an energy consuming material 7 formed of PEI foam and a space lattice body 6 filled of glass fiber cloth, and then the anti-collision unit 1 is integrally formed with a vacuum infusion process. After the anti-collision unit 1 is prepared in a factory, on an installation site, the anti-collision unit 1 is fixed at the outside of the pier by use of a bolt so as to prevent vehicle collision. The number of and the arrangement manner of the anti-collision units 1 are designed according to function needs.

[0044] Several examples of an anti-collision device made of a composite material of the present invention are described above, but the protection of the present invention is not limited to these examples.

[0045] The part not involved the present invention is the same as that in the prior art or may be implemented by use of the prior art.

1. An anti-collision device made of a buffering energy-absorbing type web-enhanced composite material, comprising an anti-collision unit, wherein the anti-collision unit comprises a housing and a filling material body located in the housing, wherein the housing is a solid housing formed of a composite material surface layer or a sandwiched housing formed of a composite material surface layer internally filled with a sandwiched material, and the sandwiched material; the filling material body comprises a space lattice body and an energy consuming material, the space lattice body is formed of fiber webs arranged in the housing in a single-layered unidirectional, single-layered bidirectional, multi-layered unidirectional or multi-layered multi-directional manner, and the energy consuming material is located between the fiber webs and/or between the fiber webs and inner walls of the housing.

2. The anti-collision device made of a buffering energy-absorbing type web-enhanced composite material according to claim 1, wherein any two anti-collision units adjacent and connected to each other are connected through a connection member between each other.

3. The anti-collision device made of a buffering energy-absorbing type web-enhanced composite material according to claim 2, wherein the connection member is one of or a combination of several of a cable, a stainless steel chain, a mooring rope, a steel strand, a bolt, a nylon stick and a dowel pin.
4. The anti-collision device made of a buffering energy-absorbing type web-enhanced composite material according to claim 1, wherein a side of the anti-collision unit is provided with anti-collision buffering facilities, the anti-collision buffering facilities are arranged at an inner side of the anti-collision unit at an interval through fasteners, and the anti-collision buffering facility is made of a rubber fender or an anti-collision bag internally provided with the filling material body.

5. The anti-collision device made of a buffering energy-absorbing type web-enhanced composite material according to claim 1, wherein the composite material surface layer is made of fiber and resin, wherein the fiber is at least one of carbon fiber, glass fiber, basalt fiber, aramid fiber, and hybrid fiber; the resin is at least one of unsaturated polyester, phthalic resin, vinyl resin, epoxy resin, inorganic resin and a thermoplastic resin material.

6. The anti-collision device made of a buffering energy-absorbing type web-enhanced composite material according to claim 1, wherein the sandwiched material is at least one of polyurethane foam, polyvinyl chloride foam, carbon foam, PEI foam, PMI foam, Balsa wood, paulownia wood, China fir and strong core felt.

7. The anti-collision device made of a buffering energy-absorbing type web-enhanced composite material according to claim 1, wherein the energy consuming material is at least one of polyurethane foam, polyvinyl chloride foam, carbon foam, PEI foam, PMI foam, Balsa wood, paulownia wood, China fir, foam aluminum, foam sand, cellular, round pipe, Mao bamboo, rubber tyre, rubber particles, rubber block, polyurethane elastomer, sand, a mixture of foam particles and sand, polyphenyl mortar, hollow pipe, and hollow plastic ball.

8. The anti-collision device made of a buffering energy-absorbing type web-enhanced composite material according to claim 1, wherein the anti-collision unit is strip-shaped, block-shaped, rounded, elliptical, arc-shaped, in a shape of figure “7”, ring-shaped, or box-shaped.

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