TIDE SELF TUNING MODULAR WHARF RESILIENT CONNECTION SYSTEM AND METHOD

Inventors: Jacques TANGUAY, Chateau-Richer (CA); François CÔTÉ, St-Etienne-de-Lauzon (CA); Bruno LECLERC, Montmagny (CA); Octavian Corneliu TOMA, Quebec (CA)

Appl. No.: 13/225,652
Filed: Sep. 6, 2011

Related U.S. Application Data


Publication Classification

Int. Cl. E02B 3/20 (2006.01)
U.S. Cl. 405/219; 403/220

ABSTRACT

A connector for connecting a floating module to a beached module of a modular wharf; the connector comprising: a resilient member adapted for resiliently opposing movement of the floating module toward the beached module; a sliding connector for slidably connecting said floating module to said beached module to allow vertical movement of the floating module relative to the beached module during tides of said body of water while restricting horizontal and lateral movement of said floating module.
TIDE SELF TUNING MODULAR WHARF RESILIENT CONNECTION SYSTEM AND METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS


TECHNICAL FIELD

The invention relates to a modular wharf. More specifically, it concerns a connector which links a floating module to a beached module of a modular wharf.

BACKGROUND OF THE ART

Modular wharves can be used wherever there is a need to compensate for the lack of infrastructure or to improve existing installations. Floating wharves can be built using barges. Examples of barges that can be used are sectional barges, deck barges, hopper barges, dump scow barges, dredging barges, crane barges, steel caissons, etc. They are an alternative to permanent wharves which require dredging, dynamiting, pouring concrete, rock filling and lengthy, costly construction. Modular wharves can be dismantled and removed once their purpose is over. They are used for loading and unloading of all types of cargo or for docking ships. They are accessible in all tide conditions. Cargo handling systems such as cranes, conveyors, lifts and others are provided on the floating wharf.

Resilient connectors are used between the modules which make up the pathways or the docking section to ensure a stable, solid and flexible wharf. The energy caused by the movements of the wharf units is dissipated at the resilient connector thereby allowing a solid yet flexible structure. The resilient connector may be pre-compressed during installation to add or to increase the wharf stability and rigidity. The connectors may be of different types. They include a compressible element, such as rubber, and a tension element which is, for example, adjustable using a tightening assembly, a hydraulic cylinder, etc.

In some situations according to bathymetry pattern, there is a need for the use of a beached wharf module together with the floating modules which could reduce the environmental impact of the modular wharf by reducing the amount of embankment, reducing installation costs and providing a sound and stable abutment. There would therefore be a need for a resilient connector between the beached module and the floating module(s) which would be designed to respond to tide movements without compromising the resilient connection behavior.

SUMMARY

According to one broad aspect of the present invention, there is provided a connector for connecting a floating module to a beached module of a modular wharf, the connector comprising: a resilient member adapted for resiliently opposing movement of the floating module toward the beached module; a wall member having a resilient member side and a slider side; a fastening assembly to secure the wall member to a first wharf module chosen from the floating module and the beached module and to sandwich the resilient member between the resilient member side of the wall member and a face of the first wharf module, the resilient member side facing the face of the first wharf module; a slider assembly having two sliding sections, one sliding section of the two sliding sections being affixed to the slider side of the wall member and another sliding section of the two sliding sections being affixed to a face of a second wharf module, the second wharf module being a different one of the floating module and the beached module, the slider side of the wall member facing the face of the second wharf module, the sliding sections being adapted to be slidably interconnected thereby securing the wall member to the second wharf module and being adapted to slide with respect to one another to allow vertical displacement of the wall member with respect to the second wharf module.

In one embodiment, the first wharf module is a floating module and the second wharf module is a beached module.

In one embodiment, the connector further comprises a chain assembly for securing the resilient member to the first wharf module, the chain assembly including chains.

In one embodiment, the fastening assembly further includes a tension load, the tension load being adapted to move the wall member towards the face of the first wharf module thereby compressing the resilient member.

In one embodiment, the resilient member is a pneumatic fender.

In one embodiment, the resilient member side of the slider member is concave between a top of the slider member and a bottom of the slider member.

In one embodiment, one of the two sliding sections of the slider assembly comprises a roller support with rollers and another one of the two sliding sections comprises at least one channel for receiving the rollers.

In one embodiment, one of the two sliding sections of the slider assembly comprises a protruding elongated flange and another one of the two sliding sections comprises a recessed elongated member for receiving the protruding elongated flange.

In one embodiment, the flange is one of trapezoidal-shapped, H-shaped, T-shaped, C-shaped and O-shaped.

In one embodiment, the connector further comprises an elongated connector, wherein both of the two sliding sections of the slider assembly comprise a recessed elongated member each for receiving a side of the elongated connector.

In one embodiment, the connector further comprises an elongated connector, wherein both of the two sliding sections of the slider assembly comprise a protruding elongated member and the elongated connector has an elongated recessed channel on each side for receiving both the protruding elongated members.

In one embodiment, the elongated connector is made of a resilient material.

In one embodiment, the connector further comprises a stopper provided on at least one of the sliding section, and the wall member for limiting displacement of at least one of the sliding sections of the slider assembly.

In one embodiment, the wall member is buoyant.

In one embodiment, the wall member is hollow and sealed.
In one embodiment, the wall member is made of a buoyant material.

In one embodiment, the two sliding sections of the slider assembly are elongated and extend generally vertically.

According to another broad aspect of the present invention, there is provided a modular wharf comprising: a beached module secured to a bottom of a body of water to prevent vertical movement of the beached module during tides of the body of water; a floating module disposed on a surface of the body of water, near the beached module; a resilient member adapted for resiliently opposing movement of the floating module toward the beached module; a sliding connector for slidably connecting the floating module to the beached module to allow vertical movement of the floating module relative to the beached module during tides of the body of water while restricting horizontal and lateral movement of the floating module.

According to another broad aspect of the present invention, there is provided a connector for connecting a floating module to a beached module of a modular wharf, the connector comprising: a resilient member adapted for resiliently opposing movement of the floating module toward the beached module; a sliding connector for slidably connecting said floating module to said beached module to allow vertical movement of the floating module relative to the beached module during tides of said body of water while restricting horizontal and lateral movement of said floating module.

In one embodiment, the sliding connector further comprises: A wall member having a resilient member side and a slider side; A fastening assembly to secure said wall member to a first wharf module chosen from said floating module and said beached module and to sandwich said resilient member between said resilient member side of said wall member and said face of said first wharf module, said resilient member side facing said face of said first wharf module; A slider assembly having two sliding sections, one sliding section of said two sliding sections being affixed to said slider side of said wall member and another sliding section of said two sliding sections being affixed to a face of a second wharf module, said second wharf module being a different one of said floating module and said beached module, said slider side of said wall member facing said face of said second wharf module, said sliding sections being adapted to be slidable interconnected thereby securing said wall member to said second wharf module and being adapted to slide with respect to one another.

In one embodiment, the sliding connector further comprising two sliding sections, each sliding section of said two sliding sections being affixed to one of said floating module and beached module each of said sliding sections being adapted to receive a portion of said resilient member and to be slidable interconnected using said resilient member thereby interconnecting said floating module to said beached module and being adapted to slide with respect to one another to allow vertical displacement of said floating module with respect to said beached module.

In one embodiment, the resilient member is made of an elastomeric resilient material.

In one embodiment, the resilient member has a cross-sectional shape with two opposed protruding ends and each protruding end of the connector is received in a corresponding recessed section of one of said sliding sections.

In one embodiment, the resilient member has a cross-sectional shape with two opposed recessed ends, wherein both of said two sliding sections have a protruding elongated member and said recessed ends of said resilient member receiving both said protruding elongated members.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Having thus generally described the nature of the invention, reference will now be made to the accompanying drawings, showing by way of illustration example embodiments thereof and in which:

**FIG. 1** includes FIG. 1A, FIG. 1B and FIG. 1C and shows example modular wharf arrangements for mooring, loading or unloading a Vessel, FIG. 1A shows a T-shaped arrangement, FIG. 1B shows an n-shaped arrangement and FIG. 1C shows a section view of a Spuded Barge.

**FIG. 2** includes FIG. 2A, FIG. 2B, FIG. 2C and FIG. 2D and shows the relevant details of the Modular Wharf, FIG. 2A is an Isometric view, FIG. 2B is a Plan view, FIG. 2C is a Section view at low tide and FIG. 2D is a Section view at high tide.

**FIG. 3** includes FIG. 3A, FIG. 3B, FIG. 3C, FIG. 3D, FIG. 3E, FIG. 3F, FIG. 3G, FIG. 3H, FIG. 3I, FIG. 3J and shows the relevant details of example Tide Self Tuning Resilient Connectors, FIG. 3A is an Isometric view of a first example connector, FIG. 3B is an Exploded view of the first example connector of FIG. 3A, FIG. 3C is a Plan view of the first example connector of FIG. 3A, FIG. 3D is a Section view at high tide of the first example connector of FIG. 3A and FIG. 3E is a Section view at low tide of the first example connector of FIG. 3A.

**FIG. 4** includes FIG. 4A, FIG. 4B, FIG. 4C, FIG. 4D, FIG. 4E and shows an embodiment of the sliders with rollers, FIG. 4A is an Exploded view, FIG. 4B is an Isometric view, first side, FIG. 4C is an Isometric view, opposite side, FIG. 4D is a Section view and FIG. 4E is a Plan view.

**FIG. 5** includes FIG. 5A, FIG. 5B, FIG. 5C, FIG. 5D, FIG. 5E and shows an embodiment of the sliders within Male and Female Part, FIG. 5A is an Exploded view, FIG. 5B is an Isometric view, first side, FIG. 5C is an Isometric view, opposite side, FIG. 5D is a Section view and FIG. 5E is a Plan view.

**FIG. 6** includes FIG. 6A, FIG. 6B, FIG. 6C, FIG. 6D, FIG. 6E and shows an embodiment of the sliders with a Rod inserted into Sleeves, FIG. 6A is an Exploded view, FIG. 6B is an Isometric view, first side, FIG. 6C is an Isometric view, opposite side, FIG. 6D is a Section view and FIG. 6E is a Plan view.

**FIG. 7** includes FIG. 7A, FIG. 7B, FIG. 7C, FIG. 7D, FIG. 7E and shows an embodiment of the sliders with a “T” slot in which an “H” Beam will slide up and down, FIG. 7A is an Exploded view, FIG. 7B is an Isometric view, first side, FIG. 7C is an Isometric view, opposite side, FIG. 7D is a Section view and FIG. 7E is a Plan view.

**FIG. 8** includes FIG. 8A, FIG. 8B, FIG. 8C, FIG. 8D, FIG. 8E and shows an embodiment of the sliders with a Slotted Tube, FIG. 8A is an Exploded view, FIG. 8D is an Isometric view, first side, FIG. 8C is an Isometric view, opposite side, FIG. 8D is a Section view and FIG. 8E is a Plan view.
FIG. 9 includes FIG. 9A, FIG. 9B, FIG. 9C, FIG. 9D, FIG. 9E and shows an embodiment of the sliders with a Slotted Tube. FIG. 9A is an Exploded view, FIG. 9B is an Isometric view, first side, FIG. 9C is an Isometric view, opposite side, FIG. 9D is a Section view and FIG. 9E is a Plan view;

FIG. 10 includes FIG. 10A, FIG. 10B, FIG. 10C, FIG. 10D, FIG. 10E and shows an embodiment of the sliders with a male and female part, FIG. 10A is an Exploded view, FIG. 10B is an Isometric view, first side, FIG. 10C is an Isometric view, opposite side, FIG. 10D is a Section view and FIG. 10E is a Plan view;

FIG. 11 includes FIG. 11A, FIG. 11B, FIG. 11C, FIG. 11D, FIG. 11E and shows an embodiment of the sliders with a Flat Plate with Angle Bars, FIG. 11A is an Exploded view, FIG. 11B is an Isometric view, first side, FIG. 11C is an Isometric view, opposite side, FIG. 11D is a Section view and FIG. 11E is a Plan view;

FIG. 12 includes FIG. 12A, FIG. 12B, FIG. 12C, FIG. 12D, FIG. 12E and shows an embodiment of the sliders with a “t-slot”, FIG. 12A is an Exploded view, FIG. 12B is an Isometric view, first side, FIG. 12C is an Isometric view, opposite side, FIG. 12D is a Section view and FIG. 12E is a Plan view;

FIG. 13 includes FIG. 13A, FIG. 13B, FIG. 13C, FIG. 13D, FIG. 13E and shows an embodiment of the sliders with elastomer, FIG. 13A is an Exploded view, FIG. 13B is an Isometric view, first side, FIG. 13C is an Isometric view, opposite side, FIG. 13D is a Section view and FIG. 13E is a Plan view;

FIG. 14 includes FIG. 14A, FIG. 14B and shows the relevant details of another example Modular Wharf, FIG. 14A is an Isometric view and FIG. 14B is an Isometric view of another example Tide Self Tuning Resilient Connector with two back walls per connector;

FIG. 15 includes FIG. 15A, FIG. 15B and shows the relevant details of another example Modular Wharf, FIG. 15A is an Isometric view and FIG. 15B is an Isometric view of another example Tide Self Tuning Resilient Connector with two fenders per Sliding & Floating Back Wall Assembly;

FIG. 16 includes FIG. 16A, FIG. 16B, FIG. 16C and shows the relevant details of another example Modular Wharf, FIG. 16A is an Isometric view, FIG. 16B is a Section view at low tide of another example Tide Self Tuning Resilient Connector in which the fender is attached to the beached module and the Sliding & Floating Back Wall Assembly is towards the floating modules and FIG. 16C is a Section view at high tide and

FIG. 17 includes FIG. 17A, FIG. 17B, FIG. 17C, FIG. 17D and shows the relevant details of another example Modular Wharf, FIG. 17A is an Isometric view of the Modular Wharf, FIG. 17B is a perspective view of another example Tide Self Tuning Resilient Connector in which the resilient member forms part of the sliders and there is no Sliding & Floating Back Wall Assembly, FIG. 17C is a Section view at low tide of the connector and FIG. 17D is a Section view at high tide;

It will be noted that throughout the appended drawings, like features are identified by like reference numerals.

DETAILED DESCRIPTION

The present invention concerns a modular wharf design with a tide self tuning resilient connector. FIG. 1A and FIG. 1B show example arrangements of a proposed installation.

FIG. 1A (T-shaped arrangement) and FIG. 1B (t-shaped arrangement) show example modular wharf arrangements for mooring, loading or unloading a Vessel 101 such as a Panamax. The Vessel 101 leans on Fenders 113 which are attached to Floating Modules 103. Two Spudged Barges 104, secured by Spuds 105, provide stable points to secure Floating Modules 103 with Cables 106. The Modular Wharf 103 is also linked to Shore Anchors 109 with Cables 106 and to Beached module 112 via the Tide Self Tuning Resilient Connectors 115. The Beached module 112 is secured with two Spuds 105 and Cables 106 to Shore Anchors 109 as well. Furthermore, Spudged Barges 104 offer additional mooring bollards satisfying different vessel lengths or positions, giving wharf operation flexibility. Spudged Barges 104 are themselves linked to Off Shore Anchors 108 via an Anchor Chain 107 and to Shore Anchors 109 via Cables 106.

The Embankment 111 gives access from the ground to the Modular Wharf. Two Ramps 110 allow vehicle or pedestrian circulation between wharf modules. Shore Boundary Line 112 will move back and forth according to tide level. FIG. 1C shows a section view of a Spudged Barge 104. Two Spuds 105 penetrate Sea Floor 113 and restrict translation movements of Spudged Barge 104. Spuds 105 let Spudged Barge 104 move vertically according to Water Line 114 changing with tide.

On FIG. 2A (Isometric view), FIG. 2B (Plan view), FIG. 2C (Section view, low tide) and FIG. 2D (Section view, high tide), the relevant details of an example Modular Wharf are shown. The Beached module 102 provides a sound and stable abutment. The Floating Modules 103 are connected to Beached module 102 through the Tide Self Tuning Resilient Connectors 115. A different type of Resilient Connector 203, like rubber tubes with rectangular or trapezoidal section or other fender types well known in the art of wharf design, is used between the two Floating Modules 103 because tide has no effect at that location. Basically, this junction reduces the bending moment created between the two Floating Modules 103 when compared to what would occur with one elongated floating module. Retaining Cables 205 keep both Floating Modules 103 together by withstanding tension forces. To allow pedestrians and vehicles to access Floating Modules 103 from Beached module 102, Ramps 110 are attached to Floating Modules 103 and just laid on Beached module 102 in order to response to tide as shown on FIG. 2C and FIG. 2D.

On FIG. 3A (Isometric view), FIG. 3B (Exploded view), FIG. 3C (Plan view), FIG. 3D (Section view, high tide) and FIG. 3E (Section view, low tide), the relevant details of an example Tide Self Tuning Resilient Connector 115 are shown. On FIG. 3F (Isometric view) and FIG. 3H (Plan view), a variant of X Cable Assembly 301 is shown. FIG. 3I (Section view, high tide) and FIG. 3J (Section view, low tide) show the same information as FIG. 3D and FIG. 3E except that Fender Assembly 303 is flattened out by a compression load.

The Fender Assembly 303 transfers and absorbs loads from Floating Module 103 to Sliding & Floating Back Wall Assembly 304. X-Cables Assembly 301 attaches Sliding & Floating Back Wall Assembly 304 to Floating Modules 103. The Sliding & Floating Back Wall Assembly 304 moves on Sliders Assembly 302 which are attached on the vertical wall of Beached module 102. One Cable end of both cables of the X-Cables Assembly 301 is attached to a Tension Puller 305. Wear Pads 306 can be installed where the cables cross to protect them from wear. The other ends of both cables of X-Cables Assembly 301 are affixed to Retainers 307 which
are themselves attached to the top of the Sliding & Floating Back Wall 308. The Pneumatic Fender 309 leans on the vertical surface of the Floating Module 103 and is retained to it by Chains 310. It also leans on the other side on the Sliding & Floating Back Wall 308.

On FIG. 3F, FIG. 3G, FIG. 3H, FIG. 3I and FIG. 3J, the relevant details of a variant of X-Cables Assembly 301 is shown. The Pneumatic Fender 309 is shown flattened. Basically, Pulleys 311 are used to redirect the cable into Damping Device 312 which is affixed on Floating Modules 103.

Depending on the load cases and/or situations, it is possible to choose the most adequate sliding device. Examples of such sliding devices are shown in FIGS. 4 to 13. FIG. 4A to FIG. 13A are Exploded views, FIG. 4B to FIG. 13B are Isometric views, FIG. 4C to FIG. 13C are Isometric views, other side, FIG. 4D to FIG. 13D are Section views and FIG. 4E to FIG. 13E are Plan views.

As shown on FIGS. 4A, B, C, D and E, the Slider Plate 404 is welded on Beached module 102. The Slider Plate 404 supports two Vertical Channel Beams 405 reinforced by Gussets 406 on their sides. These channels act as a guide for the rollers. The Roller Plate 401 is welded on Sliding & Floating Back Walls 308. It secures the Roller Supports 403 in place, in which Rollers 402 rotate freely. The Sliding & Floating Back Wall Assembly 304 is inserted and slid from the top or bottom into Vertical Channel Beams 405. Rollers allow up and down back wall displacement. Rollers rotate freely by ensuring that they are in contact with only one inner flange surface of the Vertical Channel Beams 405 at a time.

As shown on FIGS. 5A, B, C, D and E, the Guiding Plate 503 is welded on Beached module 102. The Guiding Plate 503 has a Female Part 504 (for example a machined metal piece). The Sliding Plate 501 bears the Male Part 502 and this last assembly is welded on Sliding & Floating Back Walls 308. The Sliding & Floating Back Wall Assembly 304 is united to Beached module 102 by inserting and sliding the Male Part 502 from the top or bottom into Female Part 504. Proper lube can then be applied into the mating assembly to reduce friction and let Sliding & Floating Back Walls Assembly 304 move adequately.

As shown on FIGS. 6A, B, C, D and E, the Guiding Plate 607 is welded on Beached module 102. The Guiding Plate 607 has Brackets 606 (for example, six brackets are used) supporting Sleeves 605 (for example three sleeves are used) in which Rod 602 slides up and down. The Rod Support 603 is welded on Sliding Plate 601 and secured by Gussets 604. To build the final assembly, the Sliding Plate 601 without the Rod 602 is welded on Sliding & Floating Back Walls 308. Then, the Rod 602 is inserted into the Sleeves 605 and temporarily held in place. Next, the Sliding & Floating Back Walls Assembly 304 is set close to the Beached module 102 and the Rod 602 is bolted or otherwise attached to the lowest and highest Rod Supports 603. Proper lube can be finally applied on the Rod 602 to reduce friction and let Sliding & Floating Back Wall Assembly 304 move adequately. In use, the displacement of the Sliding & Floating Back Walls Assembly 304 is stopped at the highest and lowest position when Rod Supports 603 gets in contact with Brackets 606. This stopping mechanism is useful to allow movement of the Sliding & Floating Back Walls Assembly 304 within a restricted range.

As shown on FIGS. 7A, B, C, D and E, the Guiding Plate 703 is welded on Beached module 102. The Guiding Plate 703 supports parts designed to form a “T” slot in which “H” Beam 702 welded on the Sliding Plate 701 will slide in up and down. The slot is composed of Vertical Plates 704 and reinforced by Gussets 705 on both sides. The Sliding Plate 701 is welded on Sliding & Floating Back Walls 308. The Sliding & Floating Back Wall Assembly 304 is inserted and slid from the top or bottom into the “T” slot welded on Guiding Plate 703. Proper lube can then be applied into the slot to reduce friction and let Sliding & Floating Back Walls Assembly 304 move adequately.

As shown on FIGS. 8A, B, C, D and E, the Guiding Plate 801 is welded on Beached module 102. The Guiding Plate 801 supports a Slotted Tube 803 reinforced on both sides by Gussets 802. A Stopper Plate 804 and Gusset 809 are welded at the bottom of the Guiding Plate 801. The Sliding Plate 810 also supports a Slotted Tube 803 reinforced on both sides by Gussets 802. The Sliding Plate 810 is welded on Sliding & Floating Back Wall 308. The Slider 811 is made of Rods 805 (for example, two rods are used) welded each side of the vertical edges of the Plate 806. A Hook 807 is welded at the top of the Slider 811. Once Sliding & Floating Back Wall Assembly 304 is adequately positioned, the Slider 811 is inserted into both Slotted Tubes 803 to create a linked assembly. The Slider 811 is bolted in the back wall Slotted Tube 803. Proper lube can then be applied into the slot to reduce friction and let the Sliding & Floating Back Walls Assembly 304 move adequately.

As shown on FIGS. 9A, B, C, D and E, the Guiding Plate 904 is welded on Beached module 102. The Guiding Plate 904 supports a Slotted Tube 905 reinforced on both sides by Gussets 906. The Sliding Plate 901 has a “Bulb Flat” 902 reinforced on both sides by Gussets 903, and it is welded on Sliding & Floating Back Walls 308. The Sliding & Floating Back Wall Assembly 304 is inserted and slid from the top or from the bottom into Slotted Tube 905. Proper lube can then be applied into slot to reduce friction and let the Sliding & Floating Back Walls Assembly 304 move adequately.

As shown on FIGS. 10A, B, C, D and E, the Guiding Plate 1006 is welded on Beached module 102. The Guiding Plate 1006 supports the Base Plate 1005 on which Angle Bar 1003 reinforced by Gussets 1004 is welded. It creates a female part. The Sliding Plate 1001 has Flat Bars 1002 and 1007 which form a t-shaped member acting as the male part of the mating assembly. The Sliding Plate 1001 is welded on Sliding & Floating Back Walls 308. The Sliding & Floating Back Wall Assembly 304 is inserted and slid from the top or the bottom into the female part. Proper lube can then be applied into the mating assembly to reduce friction and let Sliding & Floating Back Walls Assembly 304 move adequately.

As shown on FIGS. 11A, B, C, D and E, the Guiding Plate 1101 is welded on Beached module 102. The Sliding Plate 1107 is welded on the Sliding & Floating Back Wall 308. The Guiding Plate 1101 and the Sliding Plate 1107 both have Flat Bars 1102 and 1108 which form a t-shaped member. The Slider 1109 is made of a Flat Plate 1105 on which two Angle Bars 1103 are welded and reinforced by Gussets 1104. A Hook 1106 is welded at the top of the Slider 1109. Once Sliding & Floating Back Walls Assembly 304 is adequately positioned, the Slider 1109 is displaced to catch the t-shaped members and create a linking assembly. The Slider 1109 is bolted in the back wall Flat Bar 1102. Proper lube can then be applied between moving part surfaces to reduce friction and let the Sliding & Floating Back Walls Assembly 304 move adequately.
As shown on FIGS. 12A, B, C, D and E, the Guiding Plate 1201 is welded on Beached module 102. The Sliding Plate 1206 is welded on the Sliding & Floating Back Wall 308. The Guiding Plate 1201 and the Sliding Plate 1206, both have T-shaped Beam 1202 and Square Tube 1203 in a way to form a "t-slot". The Slider 1207 is made of an H-Beam 1204. A Hook 1205 is welded at the top of the Slider 1207. Once Sliding & Floating Back Wall Assembly 304 is adequately positioned, the Slider 1207 is displaced through the "t-slot" in order to create a linking assembly. The Slider 1207 is bolted in the back wall T-shaped Beam 1202 and Square Tube 1203. Proper lube can then be applied between moving part surfaces to reduce friction and let the Sliding & Floating Back Wall Assembly 304 move adequately.

As shown on FIGS. 13A, B, C, D and E, the Guiding Plate 1309 is welded on Beached module 102. The Guiding Plate 1309 supports two Tubes 1305 reinforced on both sides by Plates 1306 and Gussets 1303. Stopper Plates 1307 are welded at the top and the bottom of the Guiding Plate 1309. The Sliding Plate 1301 supports two Tubes 1304 also reinforced on both sides by Plates 1302 and Gussets 1303. The Sliding Plate 1301 is welded on Sliding & Floating Back Wall 308. The Slider 1308 is made of an elastomeric material adding resilient behavior to the whole assembly. After having installed the bottom Stopper Plate 1307, the Slider 1308 is inserted at its final location and the top Stopper Plate 1307 is then attached to temporarily prevent Slider 1308 from moving up and down. The Sliding & Floating Back Wall Assembly 304 is then displaced to let Slider 1308 be inserted and create a linking assembly. Proper lube can then be applied on sliding surfaces to reduce friction and let the Sliding & Floating Back Wall Assembly 304 move adequately.

As will be readily apparent to one skilled in the art, the guiding plates and corresponding sliding plates of the example embodiments of FIG. 4 to FIG. 13 could be interchanged and be affixed to the other of the beached module 102 and the sliding and floating back wall without departing from the present invention.

Other Embodiments

As will be readily understood, different configurations of the Tide Self Tuning Resilient Connector are possible without departing from the present invention. FIG. 14, FIG. 15, FIG. 16 and FIG. 17 show other example configurations to illustrate different embodiments.

FIG. 14 includes FIG. 14A, FIG. 14B and shows the relevant details of another example Tide Self Tuning Resilient Connector 1400 with two Sliding & Floating Back Walls Assemblies per Connector. The Sliding & Floating Back Walls Assemblies 1404 of each Connector 1400 do not need to be attached to one another. Each Sliding & Floating Back Walls Assembly has at least one Slider 1402. In FIG. 14, the Sliding & Floating Back Walls Assemblies 1404 are not attached to one another and can move vertically independently using their own sliders. The Pneumatic Fender 1403 is received in both Sliding & Floating Back Walls Assemblies. Shown on FIG. 14 are two sliders per Sliding & Floating Back Walls Assembly with a total of four sliders per Connector. As will be readily understood, any appropriate number of Sliding & Floating Back Walls Assembly could be used for each Connector and any appropriate number of sliders per Sliding & Floating Back Walls Assembly could be used for each Connector. In this example, a single X-Cable Assembly is used for both Sliding & Floating Back Walls Assemblies 1404. The anchoring points 1401 of the X-Cable Assembly could be moved as deemed appropriate on floating module 103 and on Sliding & Floating Back Walls Assemblies 1404. In other configurations, a X-Cable Assembly could be provided for each Sliding & Floating Back Walls Assemblies 1404.

FIG. 15 includes FIG. 15A, FIG. 15B and shows another example Tide Self Tuning Resilient Connector 1500 with two Pneumatic Fenders 1503 per Sliding & Floating Back Walls Assembly 1504. In the example shown in FIG. 15, the Sliding & Floating Back Walls Assembly 1504 has three sliders 1502. As will be readily understood, any appropriate number of Pneumatic Fenders 1503 could be used for each Connector 1504. A X-Cable Assembly 1501 is provided for the Sliding & Floating Back Walls Assemblies 1504.

As will be readily apparent to one skilled in the art, the fender of the resilient connector could be attached to the beached module, the Sliding & Floating Back Walls Assembly 304 could face the floating module and the guiding plate could be provided on the wall of the floating module without departing from the present invention. FIG. 16 includes FIG. 16A, FIG. 16B, FIG. 16C and shows another example Tide Self Tuning Resilient Connector 1600 in which the Pneumatic Fender 1603 is attached to the beached module 102 and the Sliding & Floating Back Walls Assembly 1604 has its sliders sideways towards the floating module 103. Four sliders 1601 are used for each Connector 1600. The behavior of this minor arrangement 1600 of the Tide Self Tuning Resilient Connector is shown in FIG. 16B (low tide) and FIG. 16C (high tide). A X-Cable Assembly 1602 is provided for the Sliding & Floating Back Walls Assembly 1604. In this example embodiment, an additional X-Cable or Chain Assembly 1605 is provided at the bottom of the Sliding & Floating Back Walls Assembly 1604. This additional X-Cable or Chain Assembly 1605 retains the bottom of the Sliding & Floating Back Walls Assembly 1604 towards the Pneumatic Fender 1603 and the beached module 102 even when the tide exerts pressure on the floating module 103 to pull the Sliding & Floating Back Walls Assembly 1604 away from the beached module 102. This additional X-Cable or Chain Assembly 1605 is optional and could be used on any configuration of the Connector.

The embodiment of FIG. 17 is related to that of FIG. 13. Indeed, in FIG. 13, the Slider 1308 is made of an elastomeric material adding resilient behavior to the whole assembly. If the Slider 1308 is proportioned and its shape is designed adequately, it could be sufficiently resilient to act as a bumper to avoid the collision of the floating module with the beached module. The Pneumatic Fender 309 then becomes somewhat useless and can be omitted. If the Pneumatic Fender 309 is omitted, the Sliding & Floating Back Walls Assembly 304 also can be omitted. The Guiding Plate 1309 is then welded on Beached module 102. Sliding Plate 1301 can then be welded directly on Floating module 103.

Such an embodiment where the Pneumatic Fender 309 is omitted is shown in FIG. 17. FIG. 17 shows the relevant details of another example Modular Wharf. FIG. 17A is an Isometric view of the Modular Wharf. FIG. 17B is a perspective view of another example Tide Self Tuning Resilient Connector in which the resilient member forms part of the slider assembly and there is no Sliding & Floating Back Wall Assembly. FIG. 17C is a Section view at low tide of the connector and FIG. 17D is a Section view at high tide. Connector 1700 includes two Guiding plates 1701, 1703 and a
resilient Slider 1702. The Guiding plates 1701, 1703 are
directly welded to either the Floating module 103 or the
Beached module 102. The slider 1702 is adapted to be
received in the guiding plates.

As will be readily apparent to one skilled in the art,
any means could be used to affix parts to other parts, such as
crushing, screwing, attaching, fusing, gluing, etc.

As will be readily apparent to one skilled in the art,
parts shows as separate components attached to one another
could be manufactured as a single integral piece and vice versa.

As will be readily apparent to one skilled in the art,
different combinations of illustrated configurations can be used
and other configurations can be implemented without
departing from the present invention.

In Use

The Beached module 102 provides a sound and stable
abutment from which Tide Self Tuning Resilient Connectors
115 move up and down in a synchronized way with
Floating Modules 103, according to the tide level. Sliding &
Floating Back Walls Assembly 304 is attached, using
X-Cables Assembly 301, to the Floating Modules 103. These
walls ensure a proper seat for Pneumatic Fenders 309 by
having a concave shape which contains (acting as movement
stopper) the Pneumatic Fenders 309 and transmits compression
loads to the Beached module 102 under any tide levels.

As will be readily understood, the concave shape of the wall
is optional and the resilient connector would still be useful
with a straight wall.

The vertical up and down movements of Sliding &
Floating Back Wall Assembly 304, created by its own buoyancy,
can be optionally limited in both directions by stoppers
or shock absorbers (not shown here) in order to dampen wall
movements and provide restrictions on the possible displacement
of the wall.

The movement of the Sliding & Floating Back Wall
Assembly 304 is guided by the Sliders Assembly 302 which
can take different configurations as shown in FIG. 4 to FIG.
13. Pneumatic Fenders 309 are soundly supported and
attached with Chains 310 on Floating Modules 103. Both
ends of Chains 310 are fastened with robust shackle or other
attachment means.

One end of both cables of the X-Cable Assembly
301 is connected to a Tension Puller 305 which is soundly
welded on the deck of the Floating Module 103 in order to set
and pre stress X-Cables. The pre-stress is used to change the
connection behavior by limiting allowed displacement for instance.
The other ends of these cables are equipped with
spelter sockets which are inserted into Retainer 307. A trade-off
between the displacement and the amount of load transferred
is to be taken into account at the time of selecting the
specific embodiment. Wear Pads 306 installed on the X-Cable
Assembly remove some of the friction in case of cable contact.
They protect cables against harmful wear. Wear Pads 306 can be
two half sleeves fastened together at equidistance from
both cable ends. They can be made of Ultra-high-molecular-
weight polyethylene (UHMWPE), for example.

The Tide Self Tuning Resilient Connectors 115 let
the Floating Modules 103 move almost independently and
freely (having their own trim and heel angle) under waves,
wind or vessel impact loads. The Tide Self Tuning Resilient
Connectors 115 damp displacement of the Floating Modules,
ensuring rapid energy dissipation and an adequate load transfer
from Floating Modules 103 to Beached module 102. The Tide Self Tuning Resilient Connectors 115 behave as a displaceable ball-and-socket joint through interplay between
X-Cables Assembly 301 which withstand tension stresses and
Fender Assembly 303 which withstand compression loads.
This behavior is the same at any tide level because the Tide Self Tuning Resilient Connectors 115 follow tide, providing
conditions to let the ball-and-socket joint work properly.

Example Application

A modular wharf has been designed according to
FIG. 1A. Three modules of 270 ft long, 75 ft wide, 18 ft high
and 1500 ton of displacement, forming the Modular Wharf,
were arranged to allow 75 000 ton Panamax Vessels 101 to be
docked and loaded with cargo. Two Spudded Barges 104 of
120 ft long, 40 ft wide and 10 ft high were also provided.

The Floating Modules 103 were designed to support
two 250 ton shiploaders in a way to allow loading operations
under the following conditions: 50 knots wind speed and 2
knots water current for a total longitudinal drag force of 325
ton and transversal drag force of 135 ton applied horizontally
on Floating Modules 103; 5 feet wave height; Wave length
with short breaking wave up to 20 feet; 7 feet tide; Mooring
impact of 320 ton; 25 years of operations. All components
have been calculated with a safety factor of 3. The maximum
floating module longitudinal movement (displacement)
allowable was less than 3.5 ft.

Offshore Anchors 108, Shore Anchor 109 and
Cables 106 should withstand 300 ton tension loads. The
Anchor Chain 107 has a proof test load of 450 ton and Spuds
105 should resist to 270 ton radial load. Fenders 102 have an
11 ft diameter and are 21 ft long and can withstand compression
loads of 320 ton. They are supported both sides by
Chains with chainmail rod of 2 inches diameter.

Tide Self Tuning Resilient Connectors 204 are made
of Pneumatic Fenders 309 of 11 feet diameter and 21 feet
long. These fenders can withstand compression loads of 320
ton. They are supported on both sides by Chains 310 with
chainmail rod of 2 inch diameter. The Sliding & Floating
Back Wall 308 is 40 feet long, 18 feet high, 40 inch thick at the
top and bottom, and 25 inch thick at the middle height.
The wall is reinforced in a way to withstand a compression
distributed load of 320 ton and 320 ton tension load applied at the top under any tide conditions. Each Slider
Assembly 302 is attached on vertical wall of Beached module
102. The Slider Assembly 302 is about 18 feet high, 30 inch wide and 14 inch thick. A pair of Sliders Assembly 302 can
withstand tension and compression load of 320 ton to any
position between low tide and high tide cases. One end of both
cables of the X-Cable Assembly 301 is connected to a Tension
Puller 305 which can sustain 300 ton. The other ends of both
cables of X-Cables Assembly 301 are affixed to 300 ton
capacity Retainers 307 which are themselves welded on the
top of the Sliding & Floating Back Wall 308. X-Cables are 2
inch diameter steel wire rope. They are pre-stressed at 10% of
their tension load capacity. A distance of 3 inches is main-
tained between cables but in the case of cable contact, Wear
Pads 306 allow friction free relative movement. Wear Pads
306 are UHMW half sleeves ½ inch thick and 24 inch long
that are fastened together with screws at equidistance from
both cable ends.

For the first year installation of the Modular Wharf,
all components are installed and assembled. In most applica-
tions installed where water can freeze, the Beached module...
will be kept in place year-round, even during the winter and
the rest of the Module Wharf will be dismantled for winter.
During the next year installation, the Modular Wharf will be
reassembled and attached to the existing Beach module.
[0088] The embodiments described above are intended to
be exemplary only. The scope of the invention is therefore
intended to be limited solely by the appended claims.

I/We claim:
1. A connector for connecting a floating module to a
beached module of a modular wharf, the connector compris-
ing:
a resilient member adapted for resiliently opposing move-
ment of the floating module toward the beached module;
a sliding connector for slidably connecting said floating
module to said beached module to allow vertical move-
ment of the floating module relative to the beached mod-
ule during tides of said body of water while restricting
horizontal and lateral movement of said floating module.
2. The connector as claimed in claim 1, wherein said slid-
ing connector further comprises:
a wall member having a resilient member side and a slider
side;
a fastening assembly to secure said wall member to a first
wharf module chosen from said floating module and said
beached module and to sandwich said resilient member
between said resilient member side of said wall member
and a face of said first wharf module, said resilient
member side facing said face of said first wharf module;
A slider assembly having two sliding sections, one sliding
section of said two sliding sections being affixed to said
slider side of said wall member and another sliding
section of said two sliding sections being affixed to a
face of a second wharf module, said second wharf mod-
ule different one of said floating module and said
beached module, said slider side of said wall member
facing said face of said second wharf module, said slid-
ing sections being adapted to be slidably interconnected
thereby securing said wall member to said second wharf
module and being adapted to slide with respect to one
another.
3. The connector as claimed in claim 2, wherein said first
wharf module is a floating module and said second wharf
module is a beached module.
4. The connector as claimed in claim 2, further comprising
a chain assembly for securing said resilient member to said
first wharf module, said chain assembly including chains.
5. The connector as claimed in claim 2, wherein said fasten-
ing assembly further includes a tension loader, said ten-
sion loader being adapted to move said wall member towards
said face of said first wharf module thereby compressing said
resilient member.
6. The connector as claimed in claim 2, wherein said resil-
ient member is a pneumatic fender.
7. The connector as claimed in claim 2, wherein said resil-
ient member side of the slider member is concave between a
top of said slider member and a bottom of said slider member.
8. The connector as claimed in claim 2, wherein one of said
two sliding sections of said slider assembly comprises a roller
support with rollers and another one of said two sliding sec-
tions comprises at least one channel for receiving said rollers.
9. The connector as claimed in claim 2, wherein one of said
two sliding sections of said slider assembly comprises a pro-
truding elongated flange and another one of said two sliding
sections comprises a recessed elongated member for receiv-
ing said protruding elongated flange.
10. The connector as claimed in claim 9, wherein said flange
is one of trapeze-shaped, I-shaped, T-shaped,
C-shaped and O-shaped.
11. The connector as claimed in claim 2, further compris-
ing an elongated connector, wherein both of said two sliding
sections of said slider assembly comprise a recessed elong-
ated member each for receiving a side of said elongated
connector.
12. The connector as claimed in claim 2, further compris-
ing an elongated connector, wherein both of said two sliding
sections of said slider assembly comprise a protruding elong-
ated member and said elongated connector has an elongated
recessed channel on each side for receiving both said protrud-
ing elongated members.
13. The connector as claimed in claim 11, wherein said
elongated connector is made of a resilient material.
14. The connector as claimed in claim 2, further compris-
ing a stopper provided on at least one of said sliding section,
and said wall member for limiting displacement of at least one
of said sliding sections of said slider assembly.
15. The connector as claimed in claim 2, wherein said two
sliding sections of said slider assembly are elongated and
extend generally vertically.
16. The connector as claimed in claim 1, wherein said slid-
ing connector further comprising two sliding sections,
each sliding section of said two sliding sections being affixed
to one of said floating module and beached module each of
said sliding sections being adapted to receive a portion of said
resilient member and to be slidably interconnected using said
resilient member thereby interconnecting said floating mod-
ule to said beached module and being adapted to slide with
respect to one another to allow vertical displacement of said
floating module with respect to said beached module.
17. The connector as claimed in claim 16, wherein said resil-
ient member is made of an elastomeric resilient material.
18. The connector as claimed in claim 16, wherein said resil-
ient member has a cross-sectional shape with two
opposed protruding ends and each protruding end of the con-
nector is received in a corresponding recessed section of one
of said sliding sections.
19. The connector as claimed in claim 16, wherein said resil-
ient member has a cross-sectional shape with two
opposed recessed ends, wherein both of said two sliding
sections have a protruding elongated member and said
recessed ends of said resilient member receiving both said
protruding elongated members.
20. A modular wharf comprising:
a beached module secured to a bottom of a body of water to
prevent vertical movement of the beached module dur-
ing tides of said body of water; a floating module disposed on a surface of said body of
water, near said beached module; a resilient member adapted for resiliently opposing move-
ment of the floating module toward the beached module; a sliding connector for slidably connecting said floating
module to said beached module to allow vertical move-
ment of the floating module relative to the beached mod-
ule during tides of said body of water while restricting
horizontal and lateral movement of said floating module.

* * * * *