

MODULAR FLOATING AND BOTTOM SITTING NEARSHORE INFRASTRUCTURE

FIELD OF THE INVENTION

This invention relates to a modular structure for a floating infrastructure. Particularly, this invention relates to modular structures that allow expansion of the floating infrastructure to increase liveable space on Earth to address rising sea level due to climate changes.

BACKGROUND

Climate change may not be discernible to many, but it is a global phenomenon which poses to be one of the gravest challenges facing humankind. Climate change will have devastating consequences including destruction of biodiversity, loss of food sources as well as economic impacts. For many countries, the impact of climate change is evident in warmer spells and heavier rainfalls, with particular severity on rising sea levels.

Conventional static solutions such as building sea walls and land reclamation have been implemented but these are not sustainable solutions.

Thus, those skilled in the art are constantly striving to provide alternative solution for coastline protection, and provide land resiliency to support population growth, to address the problems of rising sea levels due to climate change.

SUMMARY OF THE INVENTION

The above and other problems are solved and an advance in the state of art is made by a modular structure for a floating infrastructure in accordance with this invention. A first advantage of the modular structure in accordance with this invention is that the modular structures can be easily form together to form the floating infrastructure. A second advantage of the modular structure in accordance with this invention is that the modular structure is scalable and does not require conventional method of reclaiming land. A third advantage of the modular structure in accordance with this invention is that the modular structure can be redeployed to other locations with different environmental requirements. A fourth advantage of the modular structure in accordance with this invention is that the hexagonal shape of the modular structure allows for optimal stability and scalability.

A first aspect of the invention relates to a modular structure for a floating infrastructure. The modular structure comprises: a base slab; a basement slab; a base cell form between the base slab and the basement slab; a platform deck; an external waterproof wall extending from a perimeter of the base slab to a perimeter of the platform deck; a honeycomb double wall provided along an internal surface of the external waterproof wall; a bottom hull defined between the base slab and basement slab, wherein the base cell form is between the base slab and the basement slab; and a top hull defined between the basement slab and platform deck.

In one embodiment of the first aspect of the invention, the base cell form is configured to have bee-hive like configuration.

In one embodiment of the first aspect of the invention, the modular structure further comprises a plurality of columns between the base slab and the platform deck.

In one embodiment of the first aspect of the invention, the plurality of columns extend from the base slab to the platform deck and are evenly distributed within the honeycomb double wall.

In one embodiment of the first aspect of the invention, the plurality of columns in the bottom hull are evenly distributed within the honeycomb double wall and the plurality of columns in the top hull are not evenly distributed.

5 In one embodiment of the first aspect of the invention, the modular structure further comprises multiple levels in the top hull.

In one embodiment of the first aspect of the invention, the bottom hull and top hull are hexagonal in shape.

10 In one embodiment of the first aspect of the invention, the modular structure further comprises a ballast system adapted to monitor draft and tilt of the modular structure and perform adequate ballasting to keep the modular structure to a specific draft and upright.

In one embodiment of the first aspect of the invention, the ballast system comprises a ballast water pump control system, ballast tanks housed in the honeycomb double wall and ballast water pipes for conveying water to the ballast tanks.

15 **BRIEF DESCRIPTION OF THE DRAWINGS**

The above and other features and advantages in accordance with this invention are described in the following detailed description and are shown in the following drawings:

Figure 1 illustrating a perspective view of a floating infrastructure in accordance with an embodiment of this disclosure;

20 Figure 2 illustrating a top view of the floating infrastructure in accordance with an embodiment of this disclosure;

Figure 3 illustrating a cross sectional view of a first embodiment of the floating infrastructure in accordance with an embodiment of this disclosure;

25 Figure 4 illustrating a cross sectional view of a second embodiment of the floating infrastructure in accordance with an embodiment of this disclosure;

Figure 5 illustrating a part sectional view of the floating infrastructure in accordance with an embodiment of this disclosure;

Figure 6 illustrating an exploded view of the modular structure in accordance with an embodiment of this disclosure; and

30 Figure 7 illustrating a ballast system in accordance with an embodiment of this disclosure.

DETAILED DESCRIPTION

35 This invention relates to a modular structure for a floating infrastructure. Particularly, this invention relates to modular structures that allow expansion of the floating infrastructure to increase liveable space on Earth to address rising sea level due to climate changes.

It is envisaged that sea level may rise by 0.63m in this century and global sea surface temperature could increase between 1 to 4°C due to climate change and global warming, causing destruction of coastal cities and coastal marine biodiversity. Hence, in accordance with embodiments of this invention, the modular structure for constructing the floating infrastructure of this invention provides alternative resilient and sustainable source of land which is constructed with low/zero carbon sustainable materials. The modular structure for constructing the floating infrastructure can be used to house smart and energy efficient buildings, with power generated by renewable energy sources. Further, as the modular structure are modular in nature, the floating infrastructure has enhanced scalability and adaptability which enables it to be deployed globally. Taking up sea space for floating

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infrastructure may obstruct existing vessel routes and anchorage locations, modularity of the floating infrastructure ensures that the sea space reserved for the floating infrastructure is utilized fully.

Unlike the design for offshore floating structures such as semi-submersible where the primary function is to be stationed out at sea for oil well drilling operations, the design for floating infrastructure for live, work, play purposes requires a more in-depth study into the human comfort level.

The floating infrastructure is an alternate sustainable pathway which can combat the impact of rising sea levels and at the same time create new habitats and lifestyle spaces above and below water.

Furthermore, the comfort level of the occupants of the floating platform should not be compromised even if the environmental conditions are different as compared to land based fixed structures.

The floating infrastructure also includes the following green features to promote sustainability:

- Adopt the use of green concrete such as carbon cure concrete, concrete which utilizes recycled concrete aggregates (RCA) or even concrete that utilizes cement replacement technology. The technologies help in reducing carbon output by utilizing emitted carbon dioxide for the curing of cement or conversion into fuels and other beneficial products. Cement replacement technology enables the production of concrete without the need for Portland cement, replacements such as steel slag, a waste material from steel-making plants can be used to bind the concrete instead.

- Install solar panels on the roof of the topside structures

- Harvest rainwater and treatment facilities on the roof of the topside structures

- Green coverage and green walls to promote greenery

Figure 1 shows a floating infrastructure 100 in accordance with an embodiment of this invention. Figure 2 shows a top view of the floating infrastructure 100 in accordance with an embodiment of this invention. As shown in figure 2, 3 modular structures 200 are used to construct the floating infrastructure 100. Further details on the modular structure 200 will be described below.

Figure 3 shows a cross sectional view of a first embodiment 110 of the floating infrastructure in accordance with an embodiment of this disclosure. Accordingly, the first embodiment is a 2 layers single hull modular structure 300 with dolphin piles to anchor the modular structure 300 to the seabed. The space within the hull may be used for ballast tanks, basement lifestyle components, infrastructure systems, plant rooms, water tanks etc. One skilled in the art will recognise that the number of layers within the hull is dependent on the depth of the hull and is left as a design choice for those skilled in the art.

Figure 4 illustrates a cross sectional view of a second embodiment 120 of the floating infrastructure in accordance with an embodiment of this disclosure. In the second embodiment, multiple levels of the modular structure 400 are constructed with the bottom level sitting on the seabed. Similar to the 2 layers single hull modular structure 300, the space within the hull of the multiple levels modular structure 400 may be used for ballast tanks, basement lifestyle components, infrastructure systems, plant rooms, water tanks etc. One skilled in the art will recognise that the number of layers within the hull is dependent on the depth of the hull and is left as a design choice for those skilled in the art.

Based on figures 3 and 4, one skilled in the art will recognise that each modular structure 200 comprises at least one level. Figure 5 shows a part sectional view of a modular structure 200 in accordance with an embodiment of this disclosure. The modular structure 200 comprises a bottom hull 210 and a top hull 220. While the top hull 220 shows a one layer which is similar to the 2 layers single hull modular structure 300, the top hull 220 may be divided to form multiple layers which is similar to the multiple levels modular structure 400. In short, one skilled in the art will recognise that the number of layers within the hull is dependent on the depth of the hull and is left as a design choice for those skilled in the art.

Figure 6 shows an exploded view of the modular structure 200. The modular structure 200 comprises a base slab 710, a base cell form 720, a basement slab 730, an external waterproof wall 740, columns 750, honeycomb double wall 760 and a platform deck 770. The bottom hull 210 is defined between the base slab 710 and basement slab 730 while the top hull 220 is defined between the basement slab 730 and platform deck 770.

The base cell form 720 is arranged between the base slab 710 and the basement slab 730 forming the bottom hull 210. The base cell form 720 is configured to have beehive like configuration to provide rigid strength and redundancy.

The external waterproof wall 740 extends from the perimeter of the base slab 710 to the platform deck 770. The external waterproof wall 740 is the sidewall of the modular structure 200 and defines the height of the modular structure 200. The external waterproof wall 740, basement slab 730 and platform deck 770 define an internal space forming the top hull 220. This internal space may be a single level as shown in the 2 layers single hull modular structure 300 in figure 3 or can be further divided to multiple basement levels as shown in the multiple levels modular structure 400 in figure 4. One skilled in the art will recognise that the number of levels within the top hull is dependent on the depth of the hull and is left as a design choice for those skilled in the art.

The honeycomb double wall 760 is provided along the internal surface of the external waterproof wall 740. The honeycomb double wall 760 acts as a ballast system. Figure 7 illustrates a ballast system 780 comprising ballast water pump control system 1, ballast water pipes 2 and ballast tank 3 housed in the honeycomb double wall 760. The ballast water pump control system 1 may reside in the top hull 220 in order to quickly distribute water via the ballast water pipes 2 to the relevant ballast tank 3 to distribute weight to maintain tilt and comfort.

Columns 750 are provided and extends from the base slab 710 to the platform deck 770.

As shown in figure 6, the columns 750 in the bottom hull 210 and top hull 220 are evenly distributed within the perimeter of the modular structure 200. However, in another embodiment as shown in figure 5, the columns 750 in the top hull 220 may not be evenly distributed. Specifically, the columns 750 in the bottom hull 210 are evenly spaced to evenly distribute the building loads to the columns 750 and base cell form 720 in the bottom hull 220 as a means of economic design. In this case, the bottom hull 210 allows adjacent cells in the base cell form 720 to share and disperse uneven loads transferred from the columns in the top hull 220 which support the building. This means there is some allowance to shift the columns 750 in the top hull 220, so that the columns 750 in the top hull 220 need not

be evenly spaced which allows flexibility in the spatial planning of the basement levels and topside levels.

The honeycomb double wall 760 comprises ballast tanks 3 for controlling the buoyancy of the modular structure 200. An active compensating ballast system 780 may be installed to constantly monitor draft and tilt of the modular structure 200 and perform adequate ballasting to keep the modular structure 200 to the specified draft and upright. In some embodiment, an active ballast system might not be required if the live loads (moving loads from humans, vehicles, etc) is considerably small compared to the overall module as the movements will not cause much changes to the draft/tilt of the modular structure 200. In this embodiment, the ballast system 780 would be provided to allow the transportation of the modular structure 200 as well as future relocation possibilities. The size of the bottom hull is dependent on the amount of ballast tanks required to control the buoyancy of the modular structure 200 and in order to carry the load of the top hull and structures above the top hull and this is left as a design choice to those skilled in the art.

As shown in figure 6, the modular structure 200 is hexagonal in shape. Each modular structure 200 can be adjacently coupled together by flexible coupling arms to form a cluster. As illustrated in figures 1 and 2, three modular structures 200 are coupled together to form a cluster. The modular structures 200 may be connected together via rigid or flexible connectors. The rigid connectors will basically link 2 modular structures 200 together to form a cluster. Flexible connectors allow the modular structures 200 to retain some individuality and variations in draft without impeding each other. A flexible coupling arm is an example of a flexible connector. The flexible coupling arm that can be easily installed and disengaged, keeps the modular structures secured at a safe distance from one another and also couples the motions of the each floating platform in the cluster. As more modular structures 200 are coupled together to form a big cluster of floating infrastructure, the overall mass of the floating infrastructure would increase, inevitably increasing the stability of the floating infrastructure making the floating infrastructure less susceptible to wave and tidal changes.

To reduced greenhouse gas emission, the modular structures 200 are manufactured using advanced concrete technology that either takes in carbon dioxide for curing or replaces cement with alternative materials such as metal slags, silica binders and concrete which utilizes recycled concrete aggregates (RCA).

Each modular structure 200 is hexagonal in shape with an area approximately 5,000 square meter (sqm) which can be joined and connected together to form clusters of 3, 6, and 9 or more to form the floating cities. The joining of modular structures can be done at ease with hexagon shape. Shorter lead time is required for the modular units and this allows demand for the floating cities to be fulfilled more efficiently Individual platform has an area of 5,000sqm, which is able to accommodate approximately 2000 occupants and 3 modular structure 200 when connected together can accommodate up to 6000 occupants. The figures may vary depending on how the topside structures are designed, whether they are used more for apartments, offices or other recreational purposes.

The modular floating infrastructure can be scaled and redeployed to locations with different environmental conditions around the world to tackle the issues of climate change. The design of the modular structure hexagon in shaped. Hexagon shaped modular structures are symmetrical from all sides and will result in providing optimum stability and

ease of construction. This is the best shape in terms of Modularity & Stability yet for various combinations.

5 The above is a description of exemplary embodiments of a modular floating infrastructure in accordance with this invention. It is foreseeable that those skilled in the art can and will design alternative infrastructures, installations, systems and methods based on this disclosure that infringe upon this invention as set forth in the following claims.

CLAIMS

1. A modular structure for a floating infrastructure comprising:
a base slab;
5 a basement slab;
a base cell form between the base slab and the basement slab;
a platform deck;
an external waterproof wall extending from a perimeter of the base slab to a
perimeter of the platform deck;
10 a honeycomb double wall provided along an internal surface of the external
waterproof wall;
a bottom hull defined between the base slab and basement slab, wherein the base
cell form is between the base slab and the basement slab;
a top hull defined between the basement slab and platform deck; and
15 a plurality of columns between the base slab and the platform deck wherein the
plurality of columns in the bottom hull are evenly distributed within the honeycomb double
wall and the plurality of columns in the top hull are not evenly distributed.
2. The modular structure according to claim 1, wherein the base cell form is configured
20 to have bee-hive like configuration.
3. The modular structure according to claim 1 further comprising multiple levels in the
top hull.
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4. The modular structure according to claim 1 wherein the bottom hull and top hull are
hexagonal in shape.
5. The modular structure according to any one of claims 1-4 further comprising:
30 a ballast system adapted to monitor draft and tilt of the modular structure and
perform adequate ballasting to keep the modular structure to a specific draft and upright.
6. The modular structure according to claim 5 wherein the ballast system comprises a
ballast water pump control system, ballast tanks housed in the honeycomb double wall and
35 ballast water pipes for conveying water to the ballast tanks.