

FLOATABLE STRUCTURE AND SYSTEM

FIELD OF INVENTION

The present invention relates to a floatable structure and system to support at
5 least one panel and/or an individual.

BACKGROUND TO THE INVENTION

The following discussion of the background to the invention is intended to facilitate
an understanding of the present invention. However, it should be appreciated that
10 the discussion is not an acknowledgment or admission that any of the material
referred to was published, known or part of the common general knowledge in any
jurisdiction as at the priority date of the application.

Renewable or clean energy have been gaining traction as an alternative energy
solution compared to conventional power plants. More and more geographical
15 locations around the tropical or equatorial regions are harnessing solar energy
from the Sun as a source of energy. In this regard, solar panels typically comprise
photovoltaic cells to convert solar energy to electrical energy and have traditionally
been deployed on different sites such as rooftops and facades of buildings or
houses, or at large areas such as deserts where maximum sunlight can be
20 received on the solar panels unblocked by surrounding buildings/structures,
vegetation etc.

However, in areas or geographical locations where land is scarce, it may be near
impossible to find large unblocked land for the deployment of solar panels. In
addition, due to height regulation in many urban cities, there is limited number of
25 rooftops and buildings which are suitable for deployment or installation of solar
panels. As such, there exist a need to find other suitable locations for deployment
or installation of solar panels.

An existing solution is to deploy or install solar panels at or on water bodies such
as reservoirs or open seas. Such water bodies may be suitable as they are
30 typically unblocked and the deployed solar panels can potentially receive
maximum sunlight. In the deployment of solar panels on water bodies, the solar
panels are typically deployed on floatation systems, which may include floatable
structures installed at various location(s) on the reservoirs. However, existing

floatation systems typically require different design types of floatation units for maintenance personnel to walk on (e.g. floatation units forming walkways) and floatation units for supporting the solar panels. Such arrangement may lead to increased cost of manufacturing and inefficiency during installation.

- 5 Some floating system makes use of steel truss on floatation units to support solar panels. Such design is often costly because of the use of steel.

In addition, existing floatation systems may be susceptible to waves, strong under-currents, and other elements such as wind. Hence, they may not be suitable for deployment in relatively harsh environment such as open seas.

- 10 Further existing floatation systems may not take into account the rotation of earth around the Sun which affects the amount of sunlight falling onto the solar panels throughout the day.

In light of the above, the present invention seeks to provide a floatable structure and floatation system arranged to alleviate at least one of the above-mentioned
15 problems.

SUMMARY OF THE INVENTION

- In accordance with an aspect of the disclosure, there is provided a floatable structure arranged to support at least one panel and/or an individual, said floatable
20 structure comprises a coupling portion for coupling with another floatable structure; wherein at least one surface of the floatable structure comprises a corrugated portion comprising a plurality of ridges adapted to bear load thereon.

- In some embodiments, the corrugated portion comprises a first section wherein
25 each of the plurality of ridges are has a first predetermined width, and a second section wherein each of the plurality of ridges has a second predetermined width.

- In some embodiments, the second section is around the centre or mid portion of the floatable structure, and the second width is larger than the first width.

- 30 In some embodiments, the first predetermined width is between 0.01 to 0.03 metres (m). The first predetermined width may be 0.02 m.

In some embodiments, the second predetermined width is between 0.035 metres (m) to 0.05 m. The second predetermined width may be 0.046 m.

5 In some embodiments, the corrugated portion comprises a third section wherein each of the plurality of ridges has a third predetermined width.

In some embodiments, the third predetermined width is between 0.015 to 0.035 m. The third predetermined width may be 0.027 m.

10 In some embodiments, the corrugated portion comprises the ridges formed at an angle with respect to each other to facilitate drainage of liquid.

In some embodiments, the corrugated portion comprises a panel support receiving portion for mounting of at least one support for the panel. The panel support
15 receiving portion may be in the form of one or more embedded nuts shaped and dimensioned to receive bolts for mounting the at least one panel support.

In some embodiments, the at least one support comprises a protruding flange shaped and dimensioned to be inserted into at least two of the plurality of ridges.

20 In some embodiments, the at least one support comprises a spine portion adapted to tilt the panel and an angle with respect to the surface of the floatable structure.

In some embodiments, the at least one panel is a solar panel.

25 In some embodiments, the coupling portion comprises at least one male connector and at least one female connector. The at least one male connector may be coupled to a female connector of another floatable structure.

30 In some embodiments, the at least one surface of the floatable structure is the top surface.

In some embodiments, the floatable structure comprises another corrugated portion disposed on another surface of the floatable structure. The another surface may be the surface contacting a water body in operation.

- 5 In accordance with another aspect of the disclosure, there is provided a floatable system comprising:- a plurality of floatable structures coupled to one another, each floatable structure arranged to support at least a panel and/or an individual; the floatable structure comprises a coupling portion for coupling with another floatable structure; wherein at least one surface of the floatable structure comprises a
- 10 corrugated portion comprising a plurality of ridges adapted to bear load thereon.

In some embodiments, the plurality of floatable structures are arranged to form an array.

- 15 In accordance with another aspect of the disclosure there is provided a support for use in a floating structure comprising a base; a central spine; at least one bracket coupled to a portion of the base, the bracket configured for the panel to rest thereon; wherein the central spine comprises a surface shaped and dimensioned to tilt the panel at an operative angle.

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BRIEF DESCRIPTION OF DRAWINGS

The present invention is described, by way of one or more illustrative examples, with reference to the accompanying drawings, of which:

- 25 FIG. 1 is an isometric view of a floatable structure or floatation unit;

FIG. 2A is a plan view of the floatable structure or floatation unit of FIG. 1 showing corrugations formed or disposed thereon;

- 30 FIG. 2B shows a front view of the floatable structure or floatation unit of Fig. 1;

FIG. 2C and FIG. 2D shows two side views of the floatable structure or floatation unit of Fig. 1;

FIG. 2E shows a rear view of the floatable structure or floatation unit of Fig. 1;

FIG. 3 shows an isometric view of the floatable structure or floatation unit with one or more supports for solar panel installed thereon;

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FIG. 4A is a plan view of a floatable structure or floatation unit of FIG. 3;

FIG. 4B shows a front view of the floatable structure or floatation unit of Fig. 3;

10 FIG. 4C and FIG. 4D shows two side views of the floatable structure or floatation unit of Fig. 3;

FIG. 4E shows a rear view of the floatable structure or floatation unit of Fig. 3;

15 FIG. 5A to Fig. 5D shows different isometric views of the floatable structure or floatation unit installed with supports and solar panels in accordance with some embodiments;

FIG. 5E shows a side view of the floatable structure with a panel mounted thereon;

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FIG. 6 is a plan view of a floatable system formed by connecting a plurality of floatable structures or floatation units, the floatable system arranged to support solar panels and/or individual(s) in accordance with some embodiments;

25 FIG. 7A and FIG. 7B are isometric views of the floatable system of FIG. 6, with FIG. 7B in close-up;

FIG. 8A and 8B show another embodiment of the floatable structure; and

30 FIG. 9A to 9F show alternative embodiments of panel supports and brackets. FIG. 9A to 9C illustrate a panel support with a L-shaped bracket, and FIG. 9D to 9F illustrate a panel support with a C-shaped bracket.

DETAILED DESCRIPTION

In accordance with an aspect of the invention, there is a floatable structure or floatation unit arranged to support one or more load. Such load may be in the form of at least one panel and/or an individual. The floatable structure comprises a coupling portion for coupling to another floatable structure; and wherein at least one surface of the floatable structure comprises a corrugated portion, the corrugated portion having a plurality of ridges adapted to bear the weight of at least one individual thereon.

The floatable structure is especially suited for installation of one or more solar panels, but may be suited for installation of other types of panels such as LED panels, reflector panels, panels for artistic display, poster panels, combination panels of two or more of the above, panels or equipment for installation of pyrotechnics etc. In general, the type of load carried by the floatable structure can include lightweight panel and/or individuals such as human persons.

It is appreciable that the floatable structure, when connected to other similar floatable structure, may be utilized for authorized personnel to walk on for purposes of carrying out maintenance work.

FIG. 1, FIG. 2A to FIG. 2E show embodiments of a floatable structure 10 shaped and dimensioned to support at least a solar panel and/or an individual. The floatable structure 10 comprises a coupling portion 12 for connection with one or more of other floatable structures 10. The floatable structure 10 comprises a surface having a corrugated portion 16 disposed or formed on at least one of the surfaces.

The floatable structure 10 may be shaped as a rectangular cuboid. The coupling portion 12 comprises a plurality of connectors 12a, 12b, 12c and 12d disposed at four sides of the rectangular cuboid, with the exception of two surfaces which in operation are adapted to bear load and/or be submerged or partially submerged in a water body. For ease of reference, the two surfaces are referred to as top surface 14 and bottom surface 20 as understood in a usual operating orientation where the floatable structure 10 is deployed on a water body such as a reservoir.

Disposed or formed on the top surface 14 is the corrugated portion 16. The corrugated portion 16 comprises a plurality of grooves and/or ridges, each groove or ridge spaced apart with respect to other grooves/ridges to provide rigidity and strength to the overall structure of the floatable structure 10. The grooves/ridges

may be spaced apart so as to enhance friction when one or more authorized personnel are walking on the same to maintain the floatable structure 10 or the panels installed thereon.

5 In some embodiments, the corrugated portion 16 comprises a first section 16a wherein each of the plurality of ridges within the first section 16a has a first pre-determined width, and a second section 16b wherein each of the plurality of ridges within the second section 16b has a second pre-determined width. The second section is disposed around the centre portion of the floatable structure 10, and the second width is larger than the first width. Such an arrangement is advantageous to cater for larger deformations (when a load is applied to the top surface) which may take place around the centre portion of the floatable structure 10. The second section 16b may be interspersed between two first sections 16a. In some embodiments, the second section 16b may correspond to regions around connectors 12a, 12b, 12c or 12d, or at regions where fasteners such as bolts or
10 nuts are attached thereon. In some embodiments, the corrugated portion comprises a third section 16c wherein each of the plurality of ridges within the third section 16c has a third pre-determined width. The third pre-determined width may be between the first and second pre-determined width and may be disposed between two second sections 16b. In some embodiments (not shown), the plurality
15 of ridges may be formed at an angle with respect to each other to facilitate drainage of liquid or to prevent accumulation of liquid within the grooves.

In some embodiments, the first predetermined width is between 0.01 to 0.03 metres (m). The first predetermined width may be 0.02 m.

20 In some embodiments, the second predetermined width is between 0.035 m to 0.06 m. The second predetermined width may be 0.046 m.

As illustrated, the bottom surface 20 of the floatable structure 10 may comprise another corrugated portion 22. Corrugated portion 22 may be comprise various sections 22a, 22b, 22c. These sections 22a, 22b and 22c may correspond to
30 sections 16a, 16b and 16c, or may not correspond to sections 16a, 16b and 16c, depending on the desired usage. In some embodiments where sections 22a, 22b, and 22c mirrors sections 16a, 16b, and 16c, the top surface 14 and the bottom surface 20 may be interchangeable in operation. In other words, the floatable structure may be flipped over and the bottom surface 20 becomes the top surface

14 and vice versa. In other embodiments, sections 22a, 22b, and 22c may be arranged to provide stability and the ability to withstand certain weather elements, such as water waves when the bottom surface 20 is submerged in water.

Each connector 12a, 12b, 12c, 12d is intended to be coupled with a corresponding
5 connector 12a, 12b, 12c or 12d of one or more other floatable structures 10. Some examples of possible connections are described as follows.

The connector 12a comprises two flanges arranged to protrude from a middle region of a first longer side of the rectangular cuboid. There is a predetermined distance between the two flanges. The predetermined distance between the two
10 flanges may form a slot for receiving a corresponding flange from another connector. Connector 12a may mate with connector 12b or connector 12c of another floatable structure 10. Each of the two flanges comprise fastener receiving portions such as screw threads or drilled holes, so as to receive fasteners such as pins , bolts, nuts, or screws once the connector 12a is mated.

15 In some embodiments, the fasteners may be formed partially of plastic material. For example, in some embodiments where the fasteners are bolts, the core of the bolt may include plastic material and the outer a composite material with a coating of plastic.

The connector 12b comprises a central T-shaped spine arranged to protrude from
20 a first shorter side of the rectangular cuboid. The vertical part of the T-shaped spine is shaped and dimensioned to be received in the slot between the two flanges of connector 12a or 12d. The two flanges of the connector 12a or 12d of another floatable structure 10 may in turn be slotted to un-protruded regions beside the central spine of the connector 12b. Fastener receiving portions such as
25 screw threads or drilled holes may be formed on the horizontal part of the T-shaped spine, so as to receive fasteners such as stainless steel pins or screws once the connector 12b is mated.

The connector 12c comprises two slots spaced apart by a predetermined distance and is arranged around a middle region of a second longer side of the rectangular
30 cuboid. The two slots are shaped and dimensioned, as well as spaced apart for insertion by the two flanges of connector 12a or connector 12d of another floatable structure 10. Fastener receiving portions such as screw threads or drilled holes may be formed on the two slots, so as to receive fasteners such as stainless-steel pins or screws once the connector 12c is mated.

The connector 12d comprises two flanges arranged to protrude from a second shorter side of the rectangular cuboid, and is shaped similarly to the connector 12a for coupling with connector 12b or 12c of another floatable structure 10. Likewise, each of the two flanges comprise fastener receiving portions such as screw
5 threads or drilled holes, so as to receive fasteners such as stainless-steel pins, screws, or nylon, composite material with plastic material on the outside and plastic material for the core of the bolt once the connector 12a is mated.

In some embodiments, the grooves of one or more of the corrugated portions 16a, 16b, 16c, 20a, 20b, 20c may be cambered with a slope of between 1 degree to 10
10 degrees to mitigate or minimize accumulation of water within the grooves, which can cause safety hazard or breed undesirable insects such as mosquitoes.

As may be appreciated, connector 12a and connector 12d may be regarded as male connectors and connector 12b and connector 12c may be regarded as female connectors. It is appreciable that each connector 12a, 12b, 12c and 12d
15 may be coupled to a longer side or shorter side of an adjacent floatable structure 10. Therefore it may be appreciable that multiple floatable structures 10 may be joined together at shorter ends and longer ends to form a floatable system 100 as will be described subsequently.

Advantageously, the floatable structure 10 is made from high-density polyethylene (HDPE) as HDPE is durable and will not degenerate when it comes into contact
20 with water even after several decades. It would be understood that besides HDPE, the floatable structure 10 can also be made of other materials which have the above-mentioned advantage. An example of a material that can be used is polypropylene. In some embodiments, aluminium, concrete and/or steel as well as
25 their compounds may be utilized.

At opposing ends of the floatable structure 10 on the top surface 14 there may each comprise a ridge 16d which is has a fourth pre-determined width. The fourth pre-determined width is typically larger than the first and third pre-determined width. The ridges 16d comprises slots 24 to receive fasteners such as nuts 26.
30 Each ridge 16d may be configured to receive four nuts 26 embedded therein. Nuts 26 are positioned to receive panel supports 30.

It is to be appreciated that there may not be a section corresponding to section 16d on the bottom surface 20 of the floatable structure 10.

The payload of each floatable structure 10 is around 30 kilograms (kg). Each floatable structure 10 can support a weight of up to around 102 kg (or 1 kN). For a floatable structure 10 that has a payload of around 30 kg, the length is around 1.260 metres and the width is around 0.4 metres, and the height is around 0.215 metres.

Referring to FIG. 3, FIGS. 4A to 4E, and FIGS. 5A to 5D, the floatable structure 10 may be configured for panel supports 30 to be mounted thereon. In some embodiments, the floatable structure 10 comprises one or more panel support receiving portions for panel supports to be mounted thereon. Such panel support receiving portion may be in the form of one or more embedded nuts (such as nuts 26) shaped and dimensioned to receive bolts for mounting the at least one panel support. It is appreciable that the panel supports 30 are mounted on the floatable structures 10 that are used for deployment and/or installation of panels. They are not mounted on the floatable structures 10 that are utilized for maintenance works, or as walkways. The panel supports 30 may be referred to as support pillows, as they are configured for a solar panel to rest on. Each floatable structure 10 may be mounted with two panel supports 30. In some embodiments, the panel support 30 comprises a central spine 32 covered by brackets 34 configured for a panel 40 to rest thereon. The panel 40, when positioned on bracket 34, may be fastened using screws or other fastening means (not shown). Once held in place, the panel 40 is tilted at an angle with respect to the horizontal. In some embodiments, the angle is ten (10) degrees. Such an arrangement allows for each panel 40 to be tilted to facilitate washing/cleansing of accumulated dust and other impurities formed/accumulated on the surface of the PV support 30.

Referring to side views shown in FIGS. 4C and 4D, the panel supports 30 further comprises two legs 36 which may be positioned or inserted into two grooves adjacent to the ridge 16d. A portion 38 between the two legs 36 is secured to the ridge 16d via bolts which in turn engages the embedded nuts on the ridge 16d.

In some embodiments, the height of the panel support 30 may be adjusted so as to provide variation to the tilted angle.

FIGS 5A to 5D show various isometric view of the floatable structure 10 with panel support(s) 30 and panel 40 resting thereon. It can be seen from FIG. 5A that one floatable structure 10 can support a panel 40. This is advantageous over the

arrangement where two or more floatable structures 10 are utilized to support a panel on water. If there are two or more floatable structures 10 deployed to support one single panel, there may be differential settlement between the different floatable structures 10 when waves are present. This may inadvertently
5 cause tension or stress on the panel 40.

In some embodiments as shown in FIG. 5C and FIG. 5D, a bracket 42 may be disposed or positioned at an end further from the panel support(s) 30. The bracket 42 may be fastened to another ridge 16d, so that the panel 40 is securely held in
10 place.

In some embodiments (not shown), instead of shaped in the form of 'pillows', the panel supports 30 may be in the form of steel vertical supports.

15 In some embodiments, a surface of the floatable structure 10 may be mounted with supports for the purpose of minimizing contact between the bottom of the floatable structure 10 and the surface it is placed on. The supports may be made of rubber or other suitable material. Such configurations may minimize contact between the corrugated portions 16, 22 with other corrugated portions 16, 22
20 (when arranged in a stacked configuration). In some embodiments, a plurality of supports may be positioned at each corner of the floatable structure 10.

In some embodiments, one or more bolt sleeves may be configured to be inserted into a connector 12a or 12d of the floatable structure 10. The bolt sleeve 1004 may
25 configured to be tapered. The hole formed in the connector 12a or 12d for insertion may also be tapered. Such tapered configurations facilitate removal after the manufacturing process (such as blow moulding).

In accordance with another aspect of the disclosure, there is provided a floatable
30 system 100 formed by connecting a plurality of floatable structures 10 described in earlier embodiments. Each floatable structure 10 is able to support at least a panel, such as a solar panel and/or an individual for maintenance work to be carried out. Each floatable structure 10 comprises coupling portion 12 for coupling with another floatable structure 10; wherein at least one surface of the floatable

structure 10 comprises a corrugated portion comprising a plurality of ridges adapted to bear load thereon.

The plurality of floatable structures 10 can be coupled to one another at the connectors 12a, 12b, 12c and 12d as described earlier. With reference to FIG. 6, FIG. 7A and FIG. 7B, multiple floatable structures 10 may be connected with one another to form a floatable system in the form of an array.

With reference to FIG. 6, a rectangular array 600 is formed comprising sixteen panel bearing floatable structures 10, each panel 40 supported by a floatable structure 10. Each of the panel bearing floatable structure 10 are connected at one end to another panel bearing floatable structure 10 and connected at the other end to a non-panel bearing floatable structures, which may function as walkways for authorized personnel to walk thereon, for purpose of maintenance, for example. In the system 100 shown in FIG. 6, forty-seven floatable structures 10 are utilized as walkways, making a total of sixty-three floatable structures 10 used. With reference to FIG. 7A and 7B, either a 12b or 12d connector of the panel bearing floatable structure 10 may be connected to the 12a or 12c connector of the floatable structure 10 utilized as walkways. Such an arrangement advantageously provides for a stable system 100 wherein the forty-seven floatable structures 10 forming the walkways form a parameter around the sixteen floatable structures 10 bearing panels 40, providing for easy maintenance of the panels.

In general, the floatable system 100 may comprise any number of floatable structures 10 for supporting panels. A simple array may comprises two floatable structures 10 for supporting two solar panels, parameterized by portion adapted to function as walkways, and a central portion for supporting multiple panels. Such a configuration requires ten floatable structures 10 as walkways and two floatable structures as panel supporting structures.

Each of the floatable structure 10 may be integrally moulded, and may be formed, for example, by injection moulding, blow moulding or rotational moulding. Such a manufacturing method enables mass production of the floatable structure 10 with cost efficiency.

Various modifications will be apparent to those skilled in the art. For example, instead of the floatable structure 10 being in the form of a rectangular cuboid, the

floatable structure can be in other n-sided polygonal form such as in the form of a triangle, a square, a pentagon, a heptagon, a hexagon, an octagon and so on.

5 The connectors 12a, 12b, 12c and 12d may be permuted as known to a skilled person, as long as a similar system 100 could be achieved.

10 The width of each ridge in sections 16a, 16b, 16c and 16d as well as how each section 16a, 16b, 16c and 16d could be arranged relative to each other may be varied to provide structural rigidity, friction enhancement, structural stability, taking into account fluid dynamics principles and load bearing requirements.

15 While the various embodiments and drawings illustrate that the bottom surface 20 comprise another corrugated portion 22, it is appreciable that corrugated portion 22 may not be required in some embodiments.

20 While not shown, each floatable structure 10 may be supported by buoyancy devices such as styrofoam or other types of foam such as PU foam, It would be understood that besides PU foam and Styrofoam, other materials of the like which are able to provide buoyancy to the floatable structure 10 can also be attached to the floatable structure 10 if required.

25 The floatable structure 10 and floatable system 100 can also be installed with demountable railings (not shown), so that individuals can hold on to such railings when standing or walking on the floatable structure 10 or floatable system 100.

30 It is appreciable that the width of the ridges within corrugated portions 16, 22 may be adjusted to take into account the need of fasteners or other securing devices to be inserted thereto, for example in securing various coupling portions 12 to the main floatable structure. Such fasteners may be in the form of a stainless-steel pins to be inserted thereon.

It would be appreciated that the floatable structure 10 and floatable system 100 can be used for various purposes and not limited to supporting panels and/or individuals. This is because the floatable system 100 is made up of floatable

structures 10 that are modular and connectable to one another to form the desired floatable system 100. This gives rise to the flexibility to create various shapes and sizes of the floatable system 100 based on-site conditions, space limitation, in order to suit different needs. Furthermore, the shape and size of the floatable system 100 can be easily modified through dismantling and reconnecting the floatable structures.

Apart from supporting plants and individuals, the floatable system 100 can be configured for use as a floating platform for static displays and also for use as a venue for holding performances out in water bodies, such as reservoirs. A mobile fish farm can also be created offshore by configuring the floatable system 100 accordingly. Furthermore, the floatable system 100 can be used as an aesthetic feature and can be installed near supporting columns or bridge, or even as a temporary extension to a shoreline.

Although the panel support 30 has been described in the form of a 'pillow', other supports can be utilized to fulfil the same function of providing an angle of elevation to the panel so that, in the case where the panel is a solar panel, the angle of elevation provides for maximum exposure to sunlight.

Fig. 8A and 8B show another embodiment of a floatable structure 80. Floatable structure 80 comprises a plurality of connectors 82a, 82b disposed at each of the two opposing ends 80a and 80b of the floatable structure 80.

The connector 82a may be a male type connector shaped and dimensioned to couple to a corresponding female type connector 82b, the female connector 82b in turn shaped and dimensioned to couple to a corresponding male type connector 82a. At each end 80a, 80b, the arrangement of the male type connector 82a and female connector 82b may be alternated to facilitate coupling to another floatable structure 80. For example, end 80a of a first floatable structure 80 may be connected to end 80b of a second floatable structure 80. The male connector 82a of the first floatable structure 80 may be connected to the female connector 82b of the second floatable structure 80. There further comprise another type of connector 82c disposed at each of the two opposing ends 80c and 80d of the floatable structure 80. Each of the connector 82c and 82d may be shaped as a

plate protruding from the surface of the ends 80c and 80d, each plate comprises a hole formed there through for receiving a coupling mechanism, such as a coupling pin. When the hole of connector 80c is aligned with the hole of connector 80d of another floatable structure, the coupling pin may be inserted through the holes to
5 couple two floatable structures together.

At least a surface 84 comprise a corrugated region 86. The corrugated portion 86 comprises a plurality of grooves and/or ridges, each groove or ridge spaced apart with respect to other grooves/ridges to provide rigidity and strength to the overall structure of the floatable structure 80. The grooves/ridges may also be spaced
10 apart so as to enhance friction. The surface 84 may be a surface of the floatable structure 80, which, in operation bears load or rest on a water body. In the illustration, surface 84 includes the top and the bottom surfaces 84 but it is appreciable that in some embodiments the surface 84 can be the top surface only.

It is appreciable that the floatable structure 80 may be installed with one or more
15 panel support receiving portions as described in earlier embodiments for receiving panel supports and panels. It is however possible that the floatable structure 80 may be installed with other types of equipment such as walkways, railings etc.

FIG. 9A to 9F show different mounting brackets that can be used in conjunction with the panel support 30. The mounting brackets may be referred to as L-bracket
20 920 and C-bracket 940. Both mounting brackets, the L-bracket 920 and C-bracket 940 are suitable for use for mounting of panels. It is appreciable that each bracket 920, 940 comprise a protrusion 922 and 942 shaped and dimensioned to be inserted to a corresponding hole or depression formed on a panel.

25 In some embodiments, the floatable system 100 when deployed includes an anchorage system. The anchorage system may also be referred to as a station-keeping system. Such an anchorage system is configured to prevent the floatable system 100 from moving out of its desired boundaries and to minimize inadvertent movement when the floatable system 100 is subjected to movement of the fluid it
30 rests on. For example, the anchorage system may be configured to prevent the floatable system 100 from drifting away under adverse environmental conditions. In some embodiments, the anchorage system may include concrete sinkers utilized as deadweight anchors. A plurality of such concrete sinkers may be distributed along the length of the floatable system 100. A total of eight (8)

concrete blocks, each weighing about 4-tonnes, may be positioned at various locations to resist the drifting force exerted on the floatable system 100. In some embodiments, fasteners such as nylon ropes may be used to fasten/tie the floatable system 100 to the concrete sinkers.

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In some embodiments, one or more energy or power converters may be provided at suitable locations of the floatable system 100 (when deployed as a photovoltaic conversion farm) to convert solar energy into electrical or other forms of energy. In some embodiments, the power converters may include one or more DC (direct current) inverters.

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Experiments and analysis

Various tests were performed to study the efficacy of each floatable structure 10 and the efficacy of the whole floatable system 100.

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The parameters of the floatable structure 10 used for the tests are as follows.

a. Floatable structures 10 are made of HDPE material and produced by blow moulding techniques;

b. Each floatable structure 10 has a length of 1260 millimetres (mm), a width of 400 mm, and a height of 215 mm. The floatable structure 10 is hollow within and the shell comprises at least 3 mm thickness to achieve a compromise between strength, buoyancy and weight;

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c. Each floatable structure lightweight (around 6 kg) and is buoyant;

d. The top and bottom surfaces are corrugated with ridges and grooves running along the width of the floatable structure 10. Each floatable structure may be akin to a module equipped with either male or female connecting parts on the four sides so that the modules can be easily interconnected in its longitudinal or transverse directions.

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Load tests were performed by applying a predetermined force on (i.) a mid-portion of floatable structures 10; and (ii.) at a connection between two floatable structures

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Thirteen test samples SP1 to SP13 are used. The various test samples and the corresponding loading cases are detailed in Table 1 below. Test samples SP1, SP2, SP3, SP10, SP11, SP12, and SP13 are each a single floatable structure 10.

Test samples SP4, SP5, SP6, SP7, SP8 and SP9 each comprises two floatable structures 10 connected with each other longitudinally.

Table 1: Specimen label for each corresponding loading case

Loading case	Specimens tested
1: Single module under vertical load	SP1, SP2, SP3
2: Connected modules under vertical load	SP4, SP5, SP6
3: Connected modules under lateral load	SP7, SP8, SP9
4: Male connection part under tensile load	SP10, SP11, SP12, SP13

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Load tests performed on each of test samples SP1, SP2 and SP3 indicate that the floatable structures 10 behave elastically for loadings not exceeding 1kN or about 102 kg.

10 Load tests performed on each of the test samples SP4, SP5, SP6 for two connected floatable structures 10 subject to a monotonically increasing, concentrated vertical load applied at the inter-modular connection (on a first surface such as a top or bottom surface of the floating module 10) indicates that the moment bearing capacity of the connection is between 350 Newton-metre (Nm) and 420 Nm. The linearized rotation stiffness of the connection, up to a
15 rotation level of 0.05 radian, is found to be between 3.1 kN/rad to 3.5 kN/rad.

20 Load tests performed on each of the test samples SP7, SP8 and SP9 for two connected floating modules 10 subject to a monotonically increasing, concentrated vertical load applied at the inter-modular connection (on a second surface such as a side surface of the floating module 10 or 80) indicates that the moment bearing capacity of the connection is between 650 Newton-metre (Nm) and 1250 Nm.

25 Load tests performed on each of the test samples SP10, SP11, SP12 and SP13 in relation to a male connector under tensile load indicates that the tensile capacity is above a calculated connection load of 2.4kN, and is generally 9.4 kN and above.

The test results indicate that the floatable structure 10 is capable of withstanding the weight of panels (such as solar panels) and/or is able to withstand the weight

of an average human being. The test results also indicate that the connection portions between two floatable structures 10 are able to withstand rotation or moment force exerted on the connection portions.

Although the invention has been described in some detail by way of illustration and example, and with regard to one or more embodiments, for the purposes of clarity of understanding, it is readily apparent to those of ordinary skill in the art in light of the teachings of this invention that certain changes, variations and modifications may be made thereto without departing from the spirit or scope of the invention as defined in the appended claims.

Although various embodiments have described the use of fasteners such as stainless steel pins or screws for mating, it is appreciable that fasteners made of plastic (such as plastic pins) may be used. In general the fasteners should be suitable to withstand environmental conditions such as sun, winds, waves, sea water, rain, etc. In some embodiments, clamps may be utilized to supplement the fasteners.

It is to be appreciated while the coupling portions have been described as male, female and protruding, depressed portions, other known types of coupling portions could be used to achieve the same functions.

It is appreciated that the corrugated portion(s) 16, 86 can be in the form of different shapes that includes square, rectangle, or curved, and can be of varying dimensions.

It would be further appreciated that although the invention covers individual embodiments, it also includes combinations of the embodiments discussed. For example, the features described in one embodiment is not being mutually exclusive to a feature described in another embodiment, and may be combined to form yet further embodiments of the invention.

CLAIMS

1. A floatable module for supporting at least one panel and/or an individual,
said floatable module comprising
5 at least one surface, opposing sides and opposing ends; and
integral coupling portions provided on the opposing ends and/or opposing
sides to facilitate coupling with the integral coupling portion of another similar said
floatable module;
wherein the at least one surface comprises a corrugated portion, the
10 corrugated portion having a plurality of ridges, the corrugated portion providing
structural strength to the floatable module, and
wherein the corrugated portion comprises a panel support receiving portion
for mounting of at least one panel support onto the floatable module.
- 15 2. The floatable module according to claim 1, wherein the corrugated portion
comprises a first section, wherein each of the plurality of ridges in the first section
has a first predetermined width.
3. The floatable module according to claim 2, wherein the corrugated portion
20 comprises a second section, wherein each of the plurality of ridges in the second
section has a second predetermined width.
4. The floatable module according to claim 3, wherein the second section is
disposed around the centre or mid portion of the floatable module, and wherein the
25 second predetermined width is larger than the first predetermined width.
5. The floatable module according to any one of claims 2 to 4, wherein the first
predetermined width is between 0.01 to 0.03 metres (m).
- 30 6. The floatable module according to any one of claims 3 to 5, wherein the second
predetermined width is between 0.035 m to 0.06 m.

7. The floatable module according to any one of the preceding claims, wherein the corrugated portion comprises a third section wherein each of the plurality of ridges in the third section has a third predetermined width.

5 8. The floatable module according to claim 7, wherein the third predetermined width is between 0.015 m to 0.035 m.

9. The floatable module according to any one of the preceding claims, wherein at least one of the plurality of ridges is formed at an angle with respect to another
10 one of the plurality of ridges to facilitate drainage of liquid.

10. The floatable module according to any one of the preceding claims, wherein the panel support receiving portion is in the form of one or more embedded nuts
15 shaped and dimensioned to receive bolts for mounting the at least one panel support.

11. The floatable module according to claim 10, wherein the at least one panel support comprises a protruding flange shaped and dimensioned to be inserted into
20 at least two of the plurality of ridges.

12. The floatable module according to claim 11, wherein the at least one panel support comprises a spine portion adapted to tilt the panel at an angle with respect to the surface of the floatable module.

25

13. The floatable module according to claim 1, wherein the coupling portions comprises at least one male connector and at least one female connector.

14. The floatable module according to claim 1, wherein the floatable module is
30 shaped as a rectangular cuboid.

15. The floatable module according to claim 14, wherein the coupling portions comprises a plurality of connectors, and wherein at least one of the connectors is configured to protrude from a middle portion of the floatable module.

16. The floatable module according to claim 1, further comprises another corrugated portion disposed on another surface of the floatable module.

5 17. The floatable module according to claim 16, wherein the another surface is a surface submerged in a water body in operation.

18. The floatable module according to claim 1, wherein the at least one panel is a solar panel.

10

19. A floatable system comprising
a plurality of floatable modules as claimed in any one of the preceding claims coupled to one another.

15 20. The floatable system according to claim 19, wherein the plurality of floatable modules are arranged to form an array.

21. The floatable system according to claim 20, wherein the array comprises a perimeter portion adapted to function as walkways, and a central portion for
20 supporting multiple panels.