ARTIFICIAL REEF ANCHOR STRUCTURE

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ABSTRACT
A container for underwater placement on a sea, lake or river bottom. The container has openings in the sides, top and bottom and is filled with ballast of large boulders, cobbles, crushed coral, cast concrete modules or other materials. The openings allow water and water currents, as well as marine organisms, to pass freely therethrough. Over time, a wide assortment of marine organisms infiltrate and colonize the nooks, crevices and cavities of the ballast, thus utilizing the habitat as they would an artificial reef. One or more hitch points are provided on the container for attaching mooring lines for ships, boats, floating wind turbines or other floating structures, thereby allowing the artificial reef to anchor such structures.
Figure 5

Figure 5a
ARTIFICIAL REEF ANCHOR STRUCTURE

FIELD OF THE INVENTION

[0001] The invention relates to anchors and, more particularly, to a specialized anchor that provides an artificial reef habitat that is attractive to a wide variety of underwater organisms.

BACKGROUND OF THE INVENTION

[0002] Artificial reefs are found commonly around the world. Some are constructed to protect harbors or beaches from wind, wave or tidal forces. These types of reefs are often constructed of large, boulder-sized stones or concrete modules that are cast in a variety of shapes and sizes.

[0003] Reefs designed for protection purposes generally extend above the water line so as to deflect the forces of wind, wave or tide. These protective artificial reefs can be of any size or shape; sometimes they are circular, semi-circular, curved or straight. When they are constructed to abut a shoreline, they are sometimes called a break wall. When they extend from the shoreline out into open water, they are sometimes called a jetty. Whatever they are called, they are, in essence, an artificial reef.

[0004] Artificial reefs are often favored by fishermen, because their structure, whether constructed of natural stone or concrete modules, creates prime shelter and habitat for a wide variety of marine organisms, including desirable species such as fish, crab and lobster that are prized by both commercial fishermen and recreational sports fishermen.

[0005] Other artificial reefs are constructed solely to enhance marine habitat and are designed to provide an underwater landscape replete with nooks, crannies, caves, ledges and other subsurface features onto and into which marine organisms may attach or shelter. By providing cover and sanctuary for small organisms like algae, plankton and minnows, larger fish are attracted to forage. These fish, in turn, attract even larger fish, including sharks, tuna, bass, snapper, grouper and other large predatory fish which are at the top of the marine food chain. These types of reefs are usually totally submerged and may be constructed in shallow water near shore or in deep water miles off shore. These types of reefs may be constructed of almost any material or objects which will sink into the water column, including, but not limited to the following: natural stone, weighted tree stumps and brush, household appliances, cars, trucks, farm implements, school buses, scrap steel, subway and railway cars, factory machinery and other. Additionally, any number of decommissioned naval and merchant ships of all sizes have been scuttled in deep water to provide artificial reef structure. These types of reefs may also be constructed of cast concrete modules that may take a variety of shapes and which may have cavities molded into them.

[0006] Increasingly, artificial reefs are becoming a part of the underwater landscape wherever there is a robust interest in fishing, whether for commercial or recreational purposes, or both. As example, many U.S. states with salt water territories actively construct artificial reefs for use by recreational sports fishermen. The reef locations appear on nautical charts, and buoys are positioned over them so they may be easily located by fishermen. Certain countries, notably Japan, construct artificial reefs on a large scale for use by their commercial fishing fleets. Wherever artificial reefs are constructed, they are widely considered to be an enhancement to the marine environment and ecosystem.

[0007] A number of prior patents disclose artificial reefs specifically to attract and concentrate marine organisms. As example, U.S. Pat. No. 4,947,791 to Laier et al., U.S. Pat. No. 4,465,399 to Kikuzawa et al. and U.S. Pat. No. 4,388,019 to Kajihara show cylindrical structures that are open on the ends and essentially porous on the sides. The porosity of the sides allows small fish and other organisms, as well as ambient water currents, to freely pass through the sides. The interior spaces of the structures provide sanctuary to small fish and other organisms, while limiting access to larger predatory fish. In each of the patents, the disclosed structures can be utilized individually or in plurality. The device disclosed by Laier et al. is buoyant, and therefore suspends off the bottom and is held in place by a tether line attached to an anchor. The reefs taught by Kikuzawa and Kajihara are of sufficient density that they sink through the water column and rest on the bottom without the need of an anchor or retaining stake.

[0008] U.S. Pat. No. 6,276,301 to Pederson and U.S. Pat. No. 6,712,024 to Hall disclose inventions utilizing tire casings for the construction of artificial reefs. The Pederson device shows a habitat structure comprising tire casings baled together to form a series of chambers and cavities in which fish and other organisms can find refuge. The density of the tire casings allows them to rest on the bottom without anchorage assist. Hall shows a string of tire casings linked together and suspended vertically in the water column, with the top end attached to a flotation device and the lower end attached to an anchor means.

[0009] U.S. Pat. No. 5,454,665 to Hughes and U.S. Pat. No. 6,467,993 to Utter et al. show artificial reef components comprising vertical, pole-like structures that extend upward from the marine bottom into the water column. Each device is designed to function with other, like units. The Hughes structure comprises a buoyant rod attached flexibly to an anchor base; Utter shows a string of multi-chambered bodies sharing a cable line, with one end of the cable attached to a flotation device and the opposing end attached to an anchor. Each structure has the ability to heel over, or sway, in response to tidal currents or wave impacts.

[0010] All the above cited patents share the common feature of providing structure to serve as sanctuary, refuge and attachment surface for marine organisms ranging from algae to crabs and lobsters and finned fishes. While a number of the above cited patents employ means to hold them in place on the marine bottom, none of the above patents functions as an anchor for mooring floating vessels or structures. In summary, none of the above artificial reefs can in any respect serve the function of an anchor for anything but itself.

[0011] Anchor means cover a wide variety of sizes, shapes and designs, but may generally be assigned to two broad categories: stationary anchor means which remain in one position on the sea, harbor, river or lake bottom; and portable anchor means which are carried aboard vessels, large or small, and which are lowered into water whenever anchorage is needed and then hoisted back aboard when the vessel needs to continue passage.

[0012] Stationary anchor means are sometimes massive concrete or steel structures, which rely on gross deadweight tonnage to hold them in place. Generally, a stout cable, chain or hawse line runs from this large, submerged anchor to a
buoy which floats on the surface of the water. This buoy has
stanchions, or stout chain rings, onto which boats or ships
may tie their mooring lines. Other stationary mooring
anchors are steel, concrete or wooden devices that are driven
or buried deep into the sea, harbor, river or lake bed, with a
heavy line running from them to a surface mooring buoy or
fixed structure.

[0013] As an example, U.S. Pat. No. 3,611,734 to Mott shows a
modular anchor system specialized for the stationary
mooring of an offshore oil drilling platform. Mott discloses
floatable components comprising a rectangular foundation
member and a ballast. The members are towed to an offshore
location, where the foundation member is submerged by the
flooding of interior chambers. Once the foundation member
is resting on the marine bottom, the ballast is flooded to force
it to sink onto the foundation member, thereby utilizing the
individual members into an anchorage foundation for the
submerged legs of an oil drilling platform.

[0014] U.S. Pat. No. 4,092,944 to Van der Wal shows an
anchor comprising two, oblong cylindrical hollow bodies
joined by a series of spars. When the hollow chambers are
flooded with water, they sink to the bottom, where they can
be buried or driven into the underwater bed or floor to form
an anchor for large vessels or floating structures.

[0015] U.S. Pat. No. 4,776,140 to Wight et al. shows a
modular block anchor for supporting guy wires for trans-
mission towers and other land based structures. The anchor
comprises a crane, or base skid, onto which are stacked
deadweight blocks. Individually, the blocks are transport-
able by helicopter, but when assembled on the base skid they
cumulatively can weigh dozens of tons. While designed for
land use, the Wight et al. device could be used in underwater
applications.

[0016] Portable anchors, which are carried aboard vessels,
are generally much lighter in weight, and derive their
holding power from tongs, or flukes, which engage the
bottom when the anchor is dragged across the floor of the
water body on which the vessel floats. These drag embedded
anchors generally require long mooring lines to function
effectively. As an example, U.S. Pat. No. 3,015,299 to Towne et
al. discloses a classic drag embedded anchor, with the
anchor comprising two large steel flukes hinged on a cross
bar attached to a steel arm with a hitch point on the distal end
of the arm for attaching a heavy chain or hawse line.

[0017] The above described permanent and portable
devices may inadvertently attract marine organisms, as will
generally any object which resides on submerged ground in
either freshwater or salt water environment. As example, it
is commonly known that offshore oil platforms in the Gulf
of Mexico are attractive to a wide variety of game fish prized
by fishermen. Similarly, bridge or dock pilings in freshwater
lakes or rivers attract a variety of minnows and pan fish,
which in turn attract predatory game fish like bass and pike.
While it is well known that such structures attract marine
organisms, the underwater components of these structures
are not in any sense a “reef,” as they do not have the requisite
components of piled rocks, boulders, gravel, concrete mod-
ules or crushed coral which create myriad nooks, crannies,
ledges, crevices and cavities that both natural and artificial
reefs present. It is these said features which attract marine
organisms in the greatest variety and quantity of numbers.

SUMMARY OF THE INVENTION

[0018] The invention provides a container for underwater
placement on a sea, lake or river bottom. The container has
openings in the sides, top and bottom and is filled with
ballast of large boulders or other materials. The openings
allow water currents, as well as marine organisms, to pass
freely therethrough. Over time, marine organisms colonize
the cavity areas of the ballast, thus utilizing the habitat
within the container as an artificial reef. One or more hitch
points are provided on the container for attaching mooring
lines, thereby allowing the container to serve as an anchor
for ships and other floating vessels.

[0019] As will be seen, a general object of the invention
is to provide an artificial reef structure for mooring floating
wind turbines and other large floating structures.

[0020] Another object of the invention is to provide an
artificial reef that is relatively compact and containable
within the walls of a manufactured silo, bin, hopper, box,
drum, barrel or other mon-made container which can be
produced on a mass scale. Whatever form the container
takes, the walls and floor are semi-porous, so as to allow
entry into and egress from the interior portions for marine
organisms and ambient water currents, while retaining
within the walls and floor a significant weight of ballast
material, whether material is composed of large boulders,
stone cobble, gravel, sand, crushed coral, cast concrete
modules or other material forms and in any combination
thereof. This artificial reef may thus be regarded as a kind of
contained rock pile, with vast interior volumes of cavities,
nooks and crannies relative to the rock pile’s footprint.

[0021] One of the primary attending objects of the invention
is to provide a reef that is fashioned in such a way that
it provides one or more secure hitching points for one or
more anchor lines from which to moor boats, ships, barges
or other floating structures, including floating wind turbines.

[0022] It should be noted that the invention is especially
suited for the mooring of floating wind turbines whenever
they are arranged in a plurality of units, or in what is
commonly called an off shore wind farm.

[0023] It is believed that no other prior inventions
disclosed or so far discovered employ the dual characteristics
of effective anchor means combined with artificial reef
structure that is especially attractive to marine organisms.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] A complete understanding of the present invention
may be obtained by reference to the accompanying draw-

[0025] FIG. 1 is a side view of a preferred embodiment of
the invention;

[0026] FIG. 2 is a top view of a preferred embodiment of
the invention;

[0027] FIG. 3 is a section view showing ballast material
comprising large stones;

[0028] FIG. 3a is a section view showing an alternate
embodiment of the invention having layered strata of ballast
material comprising large stone, cobble sized stone, gravel
and sand;
FIG. 4 is a side view of a plurality of floating wind turbines, shown in simplified form, moored to a plurality of units of the invention, also shown in simplified form;

FIG. 4a is a side view of floating wind turbines and artificial reef units in various suspended configurations;

FIG. 5 is a perspective view of an alternate embodiment of the invention; and

FIG. 5a is a side view of the alternate embodiment of the invention.

The invention provides an underwater, ballast filled container with openings in the sides, top and bottom. The openings allow water currents, as well as marine organisms, to pass freely therethrough. Over time, marine organisms colonize the cavity areas of the ballast, thus utilizing the container as an artificial reef. One or more hitch points are provided on the container for attaching mooring lines, thereby allowing the container to serve as an anchor.

Referring now to FIGS. 1 through 5a, the artificial reef 12 consists of a container 10 with a plurality of openings 20 and a plurality of mooring rings 22, onto which are attached a plurality of mooring lines 24. Container 10 is filled with ballast 26.

As best seen in FIG. 2, container 10 is cylindrical, with a plurality of mooring lines 24 radiating outward at 90 degrees spacing from each other. While a circular, or cylindrical, container has certain advantages relating to strength and efficiencies of manufacture, container 10 could also be square or any other closed geometric shape, including, but not limited to, octagonal, hexagonal, pentagonal or triangular. The number of mooring lines 24 is also arbitrary, and could be any number.

Container 10 is constructed primarily of cast concrete, but other materials could be used, including, but not limited to, heavy chain link fabric (commonly known as chain link fencing), steel, wood, composite plastic or any combination thereof. Also, it should be noted that while they are not shown, reinforcing members could be integrated into the construction to stiffen and strengthen the container throughout, and at mooring stress points specifically. The mooring stress points are best shown in FIG. 2, where they correspond generally to mooring rings 22.

The size of container 10 is arbitrary. However, for the invention to effectively serve as an anchor means for structures as large as floating wind turbines, container 10 and ballast 26 should have a combined displacement of a thousand tons or more. To achieve this displacement tonnage with preferred ballast like large boulders or stone cobble requires that container 10 be approximately 30 feet high by 30 feet in diameter, or of a geometry that provides a similarly suitable interior volume of approximately 24,000 cubic feet.

As seen in FIG. 3, ballast 26 is composed of large chunks of natural stone, which are irregular in shape but roughly uniform in size. Whether natural stone, as shown in FIG. 3, or manufactured concrete forms, the irregularity of the shapes of ballast material 26 is preferred, as this creates myriad crevices, nooks, crannies, ledges and cavities when the ballast material 26 is piled in a jumbled heap inside the walls of container 10. It is these nooks, crannies and cavities that provide shelter and refuge for marine organisms, including commercially desirable ones like lobsters, crabs, clams, oysters, mussels, flounder, sea bass, grouper and others.

As seen in FIG. 3a, ballast 26 can be organized into stratified layers, as certain material types and sizes can be more attractive to specific varieties of marine species. The bottom strata, for example, could be composed of large boulder sized rocks, which is often preferred by such fin fish as grouper, bass and others. The middle strata could be composed of bowling ball sized stone cobble, which is preferred by smaller fin fish and invertebrate species like crabs and lobsters. The upper strata could be rough gravel topped with a layer of fine gravel and sand, which is preferred as a spawning bed for a variety of marine organisms.

Here, it should be noted that opening 20, in plurality, may assume a variety of sizes, shapes and spacing patterns on the same container 10. These sizes, shapes and spacing patterns may also vary from one container to the next. As mentioned above, ballast 26 may range from large boulders roughly the size of a car, to pea sized gravel and sand. Correspondingly, the size of openings 20 may range from one or two square inches in size to square feet or even square yards in size.

The size of the crevices, nooks, crannies and cavity areas found amongst the ballast 26 may also vary considerably, depending on the size of the ballast material. Large boulders, for example, may provide passageway clearances measuring in feet, thus accommodating large predatory fish like striped bass, tuna, cod, sharks and others. Very fine ballast material, like pea sized gravel and sand, may afford clearances measuring only in fractions of square inches, which could accommodate only small organisms like fish fry, shrimp, plankton and others.

As seen in FIG. 4, the invention can be utilized to moor a plurality of floating wind turbines 16, with more than one wind turbine 16 sharing a common mooring to one unit of the invention, or container 10.

As seen in FIG. 4a, container 10 may be suspended off the sea, lake or other marine bottom in a variety of configurations by attaching the container 10 to mooring lines 24. The variety of configurations is not limited to the ones shown in FIG. 4a.

As shown in FIGS. 5 and 5a, the sum of these advantages is contained in one obvious embodiment of the invention, which allows for the ballast 26 to be piled directly onto a large expanse of chain link or cable woven fabric 30 that is laid flat on the ocean, lake, river or other underwater bed or floor. In this embodiment, mooring rings 22 are fastened to the edges of the fabric 30, with mooring lines 24 attached thereto. To achieve the dead weight tonnage necessary to moor a large floating structure like a wind turbine, the fabric 30 should be at least 2,500 square feet in area. This would accommodate a rock pile of boulders 26 weighing, in total, a thousand tons or more, which is the tonnage cited above as being necessary to moor a large floating structure like a wind turbine 16, individually or in plurality. Once this rock pile of boulders is deposited on the expanse of chain link or cable woven fabric 30, the expanse of fabric 30 is effectively anchored in place, and can thus serve as a mooring station for floating structures and as an artificial reef for marine organisms.

Since other modifications and changes varied to fit particular operating requirements and environments will be apparent to those skilled in the art, the invention is not
considered limited to the example chosen for purposes of disclosure, and covers all changes and modifications which do not constitute departures from the true spirit and scope of this inventive method.

[0046] Having described the invention, what is desired to be protected by Letters Patent is presented in the subsequent appended claims.

What is claimed is:

1. An artificial reef anchor structure for securing mooring lines to floating structures while simultaneously providing habitat for underwater organisms, comprising:
   - containment means having apertures therein, for retaining ballast and to allow marine organisms to infiltrate said ballast through said apertures and at least one hitch point attached to said containment means for connecting mooring lines to said containment means; and
   - ballast to anchor said containment means while simultaneously creating habitat to attract marine organisms.

2. The artificial reef anchor structure in accordance with claim 1, wherein said containment means comprises a porous, retentive, mooring-capable container.

3. The artificial reef anchor structure in accordance with claim 1, wherein said apertures are variable in size, shape and placement pattern in the sides, top and bottom of said containment means.

4. The artificial reef anchor structure in accordance with claim 1, wherein said ballast comprises a ballast material that is more dense than water, variable in material composition, variable in size and shape, and attractive to marine life.

5. An artificial reef anchor structure for providing an anchor for securing mooring lines to floating structures while simultaneously providing habitat for underwater organisms, comprising:
   - a porous container having a plurality of apertures to allow marine organisms to infiltrate said container through said apertures and providing hitch points for mooring lines; and
   - heavier than water ballast disposed in said container for providing weighted mass to anchor said container and for creating a habitat to attract marine organisms.

6. The artificial reef anchor structure in accordance with claim 5, further comprising mooring rings attached to said container for connecting mooring lines thereto.

7. The artificial reef anchor structure in accordance with claim 5, wherein said container comprises at least one from the group: cast concrete, chain link fabric, steel, wood, and composite plastic.

8. The artificial reef anchor structure in accordance with claim 5, further comprising a fabric of material on which said ballast is disposed, said fabric lying on the bottom of a body of water.

9. The artificial reef anchor structure in accordance with claim 8, wherein said fabric is selected from the group: chain link, wire mesh, cable mesh, cast concrete, steel, wood and composite plastic.

10. The artificial reef anchor structure in accordance with claim 5, further comprising a floating structure connected to said container, said floating structure being selected from the group: wind turbine, power generator, oil or other drilling rig, aquaculture complex, fish pen complex, barge, floating casino, floating hotel, house boat, boat, ship, buoy, mooring station, boat lift and storage structure.

11. The artificial reef anchor structure in accordance with claim 8, further comprising a floating structure connected to said fabric, said floating structure being selected from the group: wind turbine, power generator, oil or other drilling rig, aquaculture complex, fish pen complex, barge, floating casino, floating hotel, house boat, boat, ship, buoy, mooring station, boat lift and storage structure.

12. The artificial reef anchor structure in accordance with claim 5, wherein the shape of said apertures is selected from the group: round, oblong, rectangle, polygon and irregular.

13. The artificial reef anchor structure in accordance with claim 5, wherein said ballast comprises materials arranged in strata.