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WAVE BREAK APPARATUS

Abstract

A floating wave break apparatus to dissipate wave action in a body of water, the apparatus including three longitudinally extending wall members each with a plurality of through holes therein. The apparatus also includes a plurality of flotation members disposed between the longitudinally extending wall members. The wave break apparatus also includes at least one restraining member above the at least one flotation member for restraining the flotation member against upward translation as well as an anchor system with at least one winch and rope combination. The winches are mounted to the restraining member and the ropes are adjustable to restrain movement of the wave break apparatus.

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Background/Summary

FIELD

[0001] This disclosure relates to a floating wave break apparatus to dissipate wave action in a body of water.

BACKGROUND

[0002] Shoreline erosion is a natural process that occurs when waves, tides, and currents erode the shore and transport sediment offshore. While erosion is a natural process, human activities such as coastal development and sea level rise have exacerbated the problem, making it a significant environmental and economic issue. Wave breaks are one of the most effective ways to prevent shoreline erosion as well as damage to docks, structures built on piers over water and to protect the coast.

[0003] Wave breaks are structures built offshore to dissipate wave energy before the wave reaches the shore. Wave breaks can take various forms, including submerged reefs, offshore wave breaks, and artificial islands. The primary function of a wave break is to reduce wave energy, which in turn reduces the velocity and erosive power of the waves.

[0004] A reduction in wave energy can help to prevent beach erosion and protect the coastline from storm surges and tidal flooding. Secondly, wave breaks can create calm water zones that are ideal for swimming, fishing, and other recreational activities. Lastly, wave breaks can provide habitat for marine life, which can help restore ecosystems and enhance biodiversity.

[0005] There are several types of wave breaks, each with its advantages and disadvantages. Submerged reefs, for example, are constructed by placing large boulders or concrete structures on the seabed. These structures break the waves before they reach the shore, dissipating their energy and reducing erosion. The disadvantage of submerged reefs is that they can be difficult to construct and maintain, and they may be a hazard to boats and other watercraft.

[0006] Offshore wave breaks, on the other hand, are structures built offshore to break waves before they reach the shore. These structures can be made of concrete, rock, or steel, and they are typically submerged to a depth that allows boats to pass over them safely. The advantage of offshore wave breaks is that they are relatively easy to construct and maintain, and they can be effective in reducing wave energy and erosion. However, they can be expensive to build, and they may create navigational hazards for boats and other watercraft.

[0007] In conclusion, wave breaks are an effective way to prevent shoreline erosion and protect the coast. They can significantly reduce wave energy, create calm water zones for recreational activities, and provide habitat for marine life. However, the choice of wave break will depend on various factors such as the cost, ease of construction, and environmental impact.

SUMMARY

[0008] Disclosed herein is a floating wave break apparatus configured to optimize the dissipation of wave action in a body of water. The configuration of the disclosed apparatus has been optimized to reduce the energy of wave action utilizing a field of study known as computational fluid dynamics. This area of study, henceforth referred to as CFD, has become an essential tool in many fields of

[0009] engineering and science. Advances in computing technology, software development, and mathematical modeling techniques have helped to improve the accuracy and efficiency of CFD simulations, making it an increasingly valuable tool for solving complex fluid dynamics problems.

[0010] CFD is a branch of fluid mechanics that uses numerical analysis and algorithms to analyze and solve problems that involve the behavior of fluids. CFD has become a valuable tool in engineering and scientific research, allowing engineers and scientists to simulate and analyze complex fluid dynamics problems that would be otherwise difficult or impossible to study experimentally.

[0011] The basic principles of CFD involve the use of mathematical equations that describe the behavior of fluids, including the Navier-Stokes equations, which govern the motion of fluids, and the continuity equation, which relates the rate of flow to the change in volume over time. These equations are used to create a mathematical model of the fluid flow, which can be solved using computational methods.

[0012] CFD is used in a wide range of industries, including aerospace, automotive, civil engineering, energy production, and environmental engineering, among others. In the aerospace industry, CFD is used to design aircraft and spacecraft, optimize aerodynamic performance, and study the behavior of fluids in the presence of high speeds and temperatures. In the automotive industry, CFD is used to optimize engine and vehicle design, improve fuel efficiency, and reduce emissions.

[0013] One of the key advantages of CFD is that it allows engineers and scientists to study complex fluid dynamics problems in a controlled and repeatable manner, without the need for expensive and time-consuming experiments. This can save significant time and money and can also help to improve the accuracy of results by allowing researchers to test a wide range of conditions and scenarios.

[0014] CFD is also a valuable tool for studying and predicting the behavior of fluids in natural and environmental systems. For example, CFD can be used to model the flow of water in rivers and oceans, study the behavior of pollutants in the atmosphere, and analyze the impact of natural disasters such as floods and tsunamis. And, as used in the development of the disclosed wave break apparatus, it allowed optimization of various features on the device to efficiently dissipate the wave energy.

[0015] The wave break apparatus disclosed herein includes a plurality of parallel, spaced apart longitudinally extending wall members each with a multitude of through holes, upper and lower edges as well as first and second opposed side edges. The disclosed apparatus also includes a first end member mounted perpendicular to the first opposed side edges of the wall members and a second end member mounted perpendicular to the second opposed side edges of the wall members.

[0016] The apparatus also utilizes at least one flotation member positioned between each of the spaced apart longitudinally extending wall members. The at least one flotation member has an upper surface, a lower surface and first and second side surfaces. At least one upper restraining member is positioned above the flotation member for restraining the flotation member against upward translation by buoyant forces. The wave break apparatus includes an anchor system with one or more winches that employ a rope. The winch is mounted to the upper restraining member and the rope is secured to an anchor at the floor of the body of water. The winches are adjustable to restrain movement of the wave break apparatus when positioned within the water body.

[0017] An object of the disclosed apparatus is to reduce the velocity and erosive power of the waves.

[0018] A further object of the disclosed apparatus is to employ a wave break that is cost effective.

[0019] A further object of the disclosed apparatus is to employ materials that can withstand the corrosive effects of immersion in water for an extended period.

[0020] A further object of the disclosed apparatus is to provide a wave break that is positionally adjustable utilizing a plurality of manually operable winches to respond to changes in elevation of the water body as well as sea state.

[0021] A further object of the disclosed apparatus is the connectability allowing extended spans of wave break.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] FIG. **1** illustrates an embodiment of the wave break apparatus in a body of water with restraining ropes secured to anchors at the bottom of the body of water;

[0023] FIG. **2** illustrates embodiments of the three wall members;
[0024] FIG. **3** illustrates an embodiment of the wave break apparatus with bracing members and first end member components shown;
[0025] FIG. **4** illustrates an embodiment of the wave break apparatus with second end member components;
[0026] FIG. **5** illustrates an embodiment of the wave break apparatus partial caps;
[0027] FIG. **6** illustrates an embodiment of the wave break flotation member configuration as among the three wall members;
[0028] FIG. **7** illustrates an embodiment of the wave break flotation member configuration positioned against the second wall member;
[0029] FIG. **8** illustrates an embodiment of the wave break flotation member fastening members;
[0030] FIG. **9** illustrates an embodiment of the winch tower;
[0031] FIG. **10** illustrates an embodiment of the wave break apparatus and the flotation members installed therein;
[0032] FIG. **11** illustrates an embodiment of the hinge members of the wave break apparatus;
[0033] FIG. **12** illustrates an embodiment of a cut-away hinge of the wave break apparatus;
[0034] FIG. **13** illustrates an embodiment of a light tower mounted to the wave break apparatus; and
[0035] FIG. **14** illustrates a computational fluid dynamics model output detailing water velocities after encountering the wave break apparatus.

DETAILED DESCRIPTION

[0036] FIG. **1** illustrates a floating wave break apparatus **10** used to dissipate wave action **12** in a body of water **14**. The wave break apparatus **10** when positioned in a water body **14** near the shoreline **16** serves to dissipate the energy of the wave action **12** and the erosive impacts of the waves action **12**. As illustrated at FIG. **2**, the floating wave break apparatus **10** utilizes a first longitudinally extending wall member **18** with a first planar surface **20** an opposed second planar surface **22**, an upper edge **24**, a lower edge **26** and opposed side edges **28**, **30**. The first longitudinally extending wall member **18** further includes a plurality of through holes **34**. The first wall member **18** is the first to encounter wave action incoming from the water body **14** traveling to the shoreline.
[0037] The apparatus **10** as disclosed herein, as illustrated at FIG. **2** also includes a second longitudinally extending wall member **40** spaced apart from and parallel to the first longitudinally extending wall member **18**. The second wall member **40** is preferably spaced apart from the first wall member **18** by about 25 inches; however, greater, or lesser spans of separation of up to 10 inches are also contemplated by this disclosure. The second longitudinally extending wall member **40** also includes a first planar surface **42**, an opposed second planar surface **44**, an upper edge **46** a lower edge **48** and opposed side edges **50**, **52**. The second longitudinally extending wall also includes a plurality of through holes **54**; however, there are a fewer number of through holes in the second wall member **40** relative to the first wall member **18**.
[0038] While the apparatus **10** as disclosed herein may be utilized as an effective wave break and be functional with only first and second wall members **18**, **40**, a preferred embodiment employs a third longitudinally extending wall member **60** spaced apart from and parallel to the second longitudinally extending wall member **40**. The third wall member **60** is preferably spaced apart from the second wall member **40** by about 25 inches; however, as previously noted, this preferred span can vary by up to 10 inches.
[0039] The third longitudinally extending wall member **60**, as illustrated at FIG. **2**, also includes a first planar surface **62**, an opposed second planar surface **64**, an upper edge **66** a lower edge **68** and opposed side edges **70**, **72**. The third longitudinally extending wall also includes a plurality of through holes **74**; however, there are a fewer number of through holes in the third wall member **60** relative to the second wall member **40**.

[0040] The wall members **18**, **40**, **60** are preferably fabricated from medium grade raw steel with a standard gauge in the range of 10-12 (0.1046 to 0.1345 inches). The reference to medium grade raw steel should not; however, be considered as limiting for this disclosure as other materials such as engineered polymers, aluminum, stainless steel, and composites are also contemplated by this disclosure. The through holes **34**, **54**, **74** in each wall member **18**, **40**, **60** have a diameter that is preferably in the range of about 6-10 inches and more preferably about 7-9 inches.
[0041] CFD modeling of the wave break apparatus **10** has demonstrated that the diameter of the openings **34**, **54**, **74** impacts the level of force applied to the apparatus from the advancing wave of water and specifically the magnitude of force applied to the wall members **18**, **40**, **60**. Wave action forces repeatedly acting upon the wave break apparatus **10** can result in damage to the apparatus **10** and can potentially dislodge the wave break apparatus anchorage **126** causing undesirable repositioning of the apparatus **10** in the wake zone. The energy extracted from the advancing wave action is effectively diminished as the water impacts each wall member and passes through the openings **34**, **54**, **74** in each of the wall members **18**, **40**, **60**.
[0042] Consequently, CFD modeling is beneficial in that it has been used to optimize the physical structure of the wave break apparatus **10** in order to maximize the reduction in wave velocity and yet to minimize the wave action forces applied to the wall members **18**, **40**, **60**. Table 1 below illustrates the output of the CFD modeling performed on a wave break apparatus **10** as disclosed herein utilizing an advancing wave speed of 60 inches per second or about 3.4 miles per hour.
[0043] As can also be seen from the CFD modeling data in Table 1, the load on the wall members **18**, **40**, **60** decreases when the opening diameter increases from 5 to 7 inches as well as when the opening diameter decreases from 5 to 3 inches, with the total number of holes in each wall member remaining constant. CFD modeling further reveals that the speed of water advancing beyond the wave break apparatus **10** drops most precipitously when the diameter of the openings **34**, **54**, **74** is about 7-8 inches.
[0044] Graphical representation of the movement of water as best illustrated at FIG. **14** reveals that wave speed is substantially reduced after passing through the wave break apparatus **10**. The wave speed drops from 60 inches per second to in the range of about 42 to 18 inches per second. Importantly, and as briefly mentioned above, the wave speed is diminished each time the advancing water impacts a wall member **18**, **40**, **60** and is forced through an opening in that wall member. As detailed above, wall member **40** has fewer openings, of the same diameter, than does wall member **18** and wall member **60** has fewer openings of the same diameter, than does wall member **40**.
[0045] With passage of the wave action through the openings **35** in the first wall member **18**, wave velocity is decreased as illustrated by FIG. **14** and as will be discussed in greater detail below. With the passage of the reduced velocity wave through the lesser number of openings **54** in the second wall member **40** the wave velocity is further decreased. Finally, upon passage of the wave action through the least number of openings **74** in the third wall member **60**, the wave action velocity is substantially diminished and will have far less deleterious impact upon sea walls, dock structures and the impact of the waves upon shoreline erosion will be diminished.
TABLE-US-00001 TABLE 1 7-inch hole 5-inch hole 3-inch hole diameter diameter diameter Force on wall 2,372 3,937 4,946 member 18 (lbs) Force on wall 2,431 1,554 1,007 member 40 (lbs) Force on wall 774 462 −77 member 60 (lbs) Total Force 5,577 5,953 5,876
[0046] The first wall member **18** utilizes about eight rows of through holes between the lower edge **26** and the upper edge **24**. The second and third wall members **40**, **60** employ a fewer number of through holes **54**, **74** with the second wall member having a greater number of through holes than the third wall member. All three wall members **18**, **40**, **60** preferably have a vertical span of about 60 inches though taller or shorter wall members are contemplated by this disclosure. Each successive wall member after the first wall member **18** has progressively fewer through holes **54**, **74** therein.
[0047] As illustrated at FIG. **3**, bracing members **80**, **82**, **84** are also contemplated for use with the

apparatus **10**. A first bracing member **80** is positioned at and secured to the first ends **28**, **50**, **70** of the three wall members **18**, **40**, **60**. A second bracing member **82** is positioned mid-span of each of the three wall members **18**, **40**, **60** and a third bracing member is positioned and secured to the second ends **30**, **52**, **72**, shown at FIG. **2**, of the three wall members. All three bracing members **80**, **82**, **84** may avoid interrupting the span of each of the wall members **18**, **40 60** depending upon the anticipated need for rigidity of the apparatus **10** (i.e., likely sea state to be encountered) and managing the complexity of fabrication of the apparatus.

[0048] A preferred embodiment of the apparatus requires the bracing members **80**, **82**, **84** to interrupt the span of all three wall members **18**, **40**, **60**. In a preferred embodiment the mid-span bracing member **82** is welded to the internal end edges **90**, **92** of all three wall members **18**, **40**, **60** as best illustrated at FIG. **7**. Likewise, end cap bracing members **80**, **84** are secured respectively to the first end side edges **28**, **50**, **70** and second end side edges **30**, **52**, **72** as best illustrated at FIG. **2**. A preferred embodiment of the bracing members utilizes medium grade steel with a thickness of the same gauge as of the wall members **18**, **40**, **60** detailed above in a rectangular configuration with intersecting diagonal cross braces **98**, **100** to maintain rigidity of the bracing members. The bracing members **80**, **82**, **84** serve to prevent buckling or folding over of the wall members **18**, **40**, **60** effectively improving overall rigidity of the apparatus.

[0049] FIG. **3** also illustrates a first end member **110** mounted to the first side edges **28**, **50**, **70** of the three wall members **18**, **40**, **60** with the first bracing member **80** interposed therebetween. The first end member **110** is a framework that includes a pair of opposed side walls **112**, **114**, a front wall **115**, a mid-wall **116** for providing structural support, a bottom panel **118**, opposed diagonal brace members **120** secured to both the bottom panel **118** and the opposed side walls **112**, **114**. Each diagonal brace **120** has a through hole **122** for allowing passage of the ropes **124** restraining the anchors **126** at the floor **128** of the body of water **14** (see also FIG. **1**). The side walls **112**, **114** of the first end member **110** also include a plurality of openings **123** to allow wave action water to enter and exit the end member **110**.

[0050] An exemplary restraining rope **124** is AmSteel® II manufactured by Samson®. The AmSteel® II rope is highly durable and has a specific gravity greater than 1.0 so it does not float in water and should slack develop in the rope during use there is a diminished likelihood of the rope becoming entangled in the prop of a passing watercraft. The use of other ropes, including wire ropes and natural fiber ropes are also contemplated by this disclosure.

[0051] FIG. **4** illustrates a second end member **130** secured to the second opposed side edges **30**, **52**, **72** of the wall members **18**, **40**, **60**. The second end member **130** is also a framework including a pair of opposed side walls **132**, **134**, a front wall **135**, a mid-wall **136** providing structural support, a bottom panel **138**, opposed diagonal brace members **140** each with a through hole **142** for allowing passage therethrough of the restraining ropes **124** to the anchors **126** at the floor **128** of the body of water **14**. The side walls **132**, **134** of the second end member **130** also include a plurality of openings **143** to allow wave action water to enter and exit the end member **130**.

[0052] The components of the first and second end members **110**, **130** are preferably fabricated from medium grade steel of the same gauge as previously referenced. As illustrated at FIGS. **2** and **5**, the end members **110**, **130** also each employ two partial caps **146**. The partial caps **146** preferably span and are secured to the upper edges **24** and **66** of the first and third wall members **18**, **60** and then span and are secured to the upper edges of the front walls **115**, **135** of the first and second end members **110**, **130**.

[0053] These partial caps **146** stiffen the end members **110**, **130** and provide a landing space for hardware, to be more fully detailed below, and include an opening **149** through which the restraining ropes **124** may pass downward to the diagonal brace member **120**, **140** before the restraining rope exits out of the apparatus **10** to the anchors **126** at the floor **128** of the body of water **14**.

[0054] FIG. **6** illustrates a pair of flotation members **150** positioned between the three longitudinally extending wall members **18**, **40**, **60** and are just two of a total of four flotation members **150** that span between the bracing members at the ends **80**, **84** and the mid-span bracing member **82**. As illustrated at FIG. **7**, the mid-span bracing member **82** in a preferred embodiment of the apparatus **10** prevents insertion of a flotation member **150** that spans the entire distance between the longitudinally opposed end edges of the wall members **18**, **40**, **60**. The flotation members **150** include an upper surface **152**, first and second side surfaces **154**, **156** and a lower surface **158**. The flotation member **150** is preferably fabricated from encapsulated expanded polystyrene; however, alternative formulations of flotation members, for example among others, marine polyurethane, is also contemplated by this disclosure.

[0055] As best illustrated at FIG. **8**, the first and second side surfaces **154**, **156** of the flotation members **150** include outwardly extending flanges **160**, **162** proximate the upper surface **152** of the flotation members **150**. The outwardly extending flanges **160**, **162** are configured for engagement with a fastener **164** extending downwardly from the restraining member **166**. Because of the outwardly extending flanges **160**, **162**, the first and second side surfaces **154**, **156** of the flotation members **150** are spaced away from the adjacent wall members **18**, **40** forming a gap **168** therebetween in the range of about 1 to 3 inches. This gap between the first side surface **154** of the flotation member **150** and the interior surface **22** of the first wall member **18** provides a route for water to transit upon a wave impacting the anchored apparatus **10** and forcing water through the plurality of through holes **34**.

[0056] FIG. **7** also illustrates the placement of the restraining member **166** as detailed above being positioned over the flotation members **150** with the objective of restraining the flotation member against upward translation by buoyant forces when the flotation member **150** is partially, or fully, submerged in the body of water **14**. The restraining member **166** is preferably a continuous flat plate secured in position with fasteners **170** being received into bent over flanges (not shown) formed at the upper edges **24**, **46**, **66** of the longitudinally extending wall members **18**, **40**, **60**. It is contemplated that the restraining member **166** could alternatively be a grate or even a plurality of discrete flat bars spanning across the wall members **18**, **40**, **60**.

[0057] As best illustrated at FIG. **9**, the apparatus **10** as disclosed herein also includes an anchor system with at least one winch **180** and rope **124** combination. In a preferred embodiment the apparatus **10** utilizes a total of four winches **180** to properly restrain the apparatus **10** in position against movement from wave action. The winch **180** is partially mounted atop the restraining member **166** and partially mounted atop the partial cap **146**. The canted leg **182** of the winch **180** is secured with fasteners **182**A to the restraining member **166** and the vertical leg **184** of the winch is secured with fasteners **184**A to the partial cap **146**. The winches **180** also utilize crank arms **185** allowing manual adjustment of the tension on each restraining rope **124** to optimize the position of the apparatus **10**.

[0058] The four winches **180** of the preferred embodiment of the apparatus **10** are each positioned atop a separate restraining member **166** and partial cap **146**. The drum **188** of the winch **180** upon which the restraining rope **124** is wrapped may be manually adjusted with the crank arm **185** to regulate the tension on the rope **124**.

[0059] In preparation for placement of the apparatus **10** into the body of water **14**, the restraining members **166** are preferably removed so that four flotation members **150** of the preferred embodiment may be secured with fasteners **164**, as best illustrated at FIG. **8**. The flotation members **150** are then positioned into the four chambers formed within the apparatus **10** by the wall members **18**, **40**, **60** and the bracing members **80**, **82**, **84**.

[0060] FIG. **10** illustrates that in a preferred embodiment, the flotation members **150** do not extend downwardly the entire vertical span “V” (for example, distance between the upper edge **24** and lower edge **26** of first wall member **18**) of the wall members **18**, **40**, **60**. The downward extension of the flotation members **150** is roughly one-half of the vertical span V of the wall members **18**, **40**, **60**. Once the flotation members **150** are secured in position with the fasteners **164** the apparatus **10** may be placed in the water body **14** proximate the location where it is to ultimately serve as a wave break. Once in the water the restraining ropes **124** are unspooled from the winch roller **188** on each of the four winches **180**. After the second end of the rope **124** passes through the opening **149** in the partial cap **146** as well as the opening **122**, **142** in the diagonal brace **120**, **140**, the anchor **126** is attached to the end of the restraining rope **124** opposite the end attached to the roller **188**.

[0061] As best illustrated at FIG. **1**, the anchors **126**, preferably four, are positioned on the floor **128** of the water body **14** at an outward diagonal distance from the apparatus **10**. The winches **180** are then adjusted to remove slack from the restraining rope **124** and the apparatus is uniformly submerged leaving only about 12-15 inches of the apparatus **10** above the surface of the body of water **14**.

[0062] As a wave advances toward the apparatus **10** it initially impacts the first wall member **18**. Advancing water moves through the holes **34** or is obstructed by the area adjacent the holes. For the water that advances through the holes **34** it next advances past the gap **168** and impacts the first side surface **156** of the flotation member **150**. Because of the solid nature of the flotation member **150** the advancing water is forced downward into the gap **168** and finally encounters a lack of obstruction at the lower surface **158** of the flotation member **150**.

[0063] By the time the advancing water has moved to the lower surface **158** of the flotation member **150** it has lost a considerable portion of the energy that it initially had upon impact with the apparatus **10** due to friction losses resulting from interaction with the wall member **18** and the first side surface **156** of the flotation member **150**. Once the water has advanced to the lower surface **158** of the flotation member **150** it can finally move forward (in the direction of the wave action) where it next encounters the second wall member **40** of the flotation member **150**. As indicated above, the second wall member **40** has fewer through holes **54** than the first wall member **18**.

[0064] The second wall member **40** being less porous (fewer through holes) than the first wall member resists passage of the water thereby extracting even more energy from the advancing wave of water. After passing through the openings **54** in the second wall member **40** the water advances across the next chamber beneath the flotation members **150** and encounters the third wall member **60**.

[0065] The third wall member **60** has even fewer holes **74** than the second wall member **40** and water attempting to escape through the holes **74** will be placing pressure on the third wall member **60** further diminishing the energy carried by the advancing water. Numerical modeling using Computational Fluid Dynamics (CFD) reveals that a substantial portion of the energy initially carried by the wave action is lost upon contact with the apparatus **10** thereby reducing the potential for wave action causing damage to the shoreline, docks, or other floating structures.

[0066] The apparatus **10** as disclosed herein is also highly modular in nature and connectable to address protection of long shorelines or extended docks. As illustrated at FIGS. **4**, **11** and **12**, mounted to the front walls **115**, **135** of the first and second end members **110**, **130** are arcuate hinge plates **200**. Preferably two hinge plates **200** are mounted to each front wall **115**, **135** with each hinge plate having a hole **202** therein. As illustrated at FIG. **12** a pin **204** is passed through the holes **202** of the hinge plates **200** thereby locking one apparatus **10** to the next. The wave break apparatus **10** can be extended a considerable distance with the use of the hinge plates **200** and locking pins **204**.

[0067] Another highly useful feature of the apparatus **10** as disclosed herein is the use of light towers **210** as illustrated at FIG. **13**. The light towers are preferably secured to a landing pad **212** upon the partial caps **146**. A preferred embodiment of the light tower **210** is one that extends above the landing pad **212** with a shaft in the range of about 30-40 inches with a solar powered light **214** at the very top. Preferably a total of four of these light towers **210** are positioned around each wave break apparatus **10** to alert boaters of the presence of the wave breaks, particularly at night when the solar powered lights are illuminated.

[0068] FIG. **14** illustrates pictorially the output of a computational fluid dynamics model of the wave break apparatus. These modeling results reveal that wave action water velocities **220** diminish substantially for the water passing through the holes **34** of the wall members **18**, **40**, **60** of the wave break apparatus **10** and to a lesser degree the velocities of water passing beneath **222** and to the sides **224** of the wave break apparatus **10**. As previously noted, the water passing to the sides **224** in the modeling at 60 inches per second, is far greater than the speed of the water passing beneath **222** and through **220** the apparatus **10** which resulted in wave action speeds of about 42 and 18 inches per second respectively. The computational fluid dynamics modeling demonstrated substantial reductions in wave velocity upon the wave contacting the apparatus **10**.
[0069] The disclosed apparatus should not be construed as limiting in any way. Instead, the present disclosure is directed toward all novel and nonobvious features and aspects of the various disclosed embodiments, alone and in various combinations and sub-combinations with one another. The disclosed apparatus is not limited to any specific aspect or feature or combination thereof, nor do the disclosed embodiments require that any one or more specific advantages be present, or problems be solved.
[0070] In view of the many possible embodiments to which the principles of the disclosed invention may be applied, it should be recognized that the illustrated embodiments are only examples of the disclosure and should not be taken as limiting the scope of the invention. Rather, the scope of the invention is defined by the following claims. I therefore claim as my invention all that comes within the scope of these claims.
[0071] The disclosure presented herein is believed to encompass at least one distinct invention with independent utility. While the at least one invention has been disclosed in exemplary forms, the specific embodiments thereof as described and illustrated herein are not to be considered in a limiting sense, as numerous variations are possible. Equivalent changes, modifications, and variations of the variety of embodiments, materials, compositions, and methods may be made within the scope of the present disclosure, achieving substantially similar results. The subject matter of the at least one invention includes all novel and non-obvious combinations and sub-combinations of the various elements, features, functions and/or properties disclosed herein and their equivalents.
[0072] Benefits, other advantages, and solutions to problems have been described herein regarding specific embodiments. However, the benefits, advantages, solutions to problems, and any element or combination of elements that may cause any benefits, advantage, or solution to occur or become more pronounced are not to be considered as critical, required, or essential features or elements of any or all the claims of at least one invention.
[0073] Many changes and modifications within the scope of the instant disclosure may be made without departing from the spirit thereof, and the one or more inventions described herein include all such modifications. Corresponding structures, materials, acts, and equivalents of all elements in the claims are intended to include any structure, material, or acts for performing the functions in combination with other claim elements as specifically recited. The scope of the one or more inventions should be determined by the appended claims and their legal equivalents, rather than by the examples set forth herein.
[0074] Benefits, other advantages, and solutions to problems have been described herein regarding specific embodiments. Furthermore, the connecting lines, if any, shown in the various figures contained herein are intended to represent exemplary functional relationships and/or physical couplings between the various elements. It should be noted that many alternative or additional functional relationships or physical connections may be present in a practical system. However, the benefits, advantages, solutions to problems, and any elements that may cause any benefit, advantage, or solution to occur or become more pronounced are not to be construed as critical, required, or essential features or elements of the inventions.
[0075] The scope of the inventions is accordingly to be limited by nothing other than the appended

claims, in which reference to an element in the singular is not intended to mean “one and only one” unless explicitly so stated, but rather “one or more.” Moreover, where a phrase similar to “at least one of A, B, or C” is used in the claims, it is intended that the phrase be interpreted to mean that A alone may be present in an embodiment, B alone may be present in an embodiment, C alone may be present in an embodiment, or that any combination of the elements A, B and C may be present in a single embodiment; for example, A and B, A and C, B and C, or A and B and C. Different cross-hatching is used throughout the figures to denote different parts but not necessarily to denote the same or different materials.
[0076] In the detailed description herein, references to “one embodiment,” “an embodiment,” “an example embodiment,” etc., indicate that the embodiment described may include a feature, structure, or characteristic, but every embodiment may not necessarily include the feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a feature, structure, or characteristic is described relating to an embodiment, it is submitted that it is within the knowledge of one skilled in the art to affect such feature, structure, or characteristic relating to other embodiments whether or not explicitly described. After reading the description, it will be apparent to one skilled in the relevant art(s) how to implement the disclosure in alternative embodiments.
[0077] Furthermore, no element, component, or method step in the present disclosure is intended to be dedicated to the public regardless of whether the element, component, or method step is explicitly recited in the claims. No claim element herein is to be construed under the provisions of 35 U.S.C. § 112(f) unless the element is expressly recited using the phrase “means for.” As used herein, the terms “comprises,” “comprising,” or any other variation thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that comprises a list of elements does not include only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus.
[0078] The invention has been described above with reference to one or more preferred embodiments, it will be appreciated that various changes or modifications may be made without departing from the scope of the invention as defined in the appended claims.

Claims

1. A floating wave break apparatus to dissipate wave action in a body of water, the apparatus comprising: a first longitudinally extending wall member with a first planar surface an opposed second planar surface, an upper edge, a lower edge and opposed side edges, the first longitudinally extending wall further comprising a plurality of through holes therein; a second longitudinally extending wall member spaced apart from and parallel to the first longitudinally extending wall member, the second longitudinally extending wall member further comprising a first planar surface, an opposed second planar surface, an upper edge a lower edge and opposed side edges, the second longitudinally extending wall comprising a plurality of through holes therein; at least one flotation member disposed between the first and second longitudinally extending wall members, the at least one flotation member comprising an upper surface and first and second side surfaces; at least one restraining member disposed above the at least one flotation member for restraining the flotation member against upward translation, the at least one restraining member secured to the upper edges of the first and second longitudinally extending wall members; and an anchor system comprising at least one winch drum and rope combination, the winch drum mounted to the restraining member and the rope with a first end secured to the winch drum and a second end secured to an anchor at the floor of the body of water, wherein the tension in the rope is adjustable with the winch drum to restrain movement of the wave break apparatus.
2. The floating wave break apparatus of claim 1, wherein the second longitudinally extending wall member comprises fewer through holes than the first longitudinally extending wall member.

3. The floating wave break apparatus of claim 1, wherein the upper edges of the first and second longitudinally extending wall members comprise bent flange members for at least one of receiving fasteners passing through openings in the at least one restraining member or welding of the upper edges to the restraining member.
4. The floating wave break apparatus of claim 1, wherein the rope comprises at least one of a metal cable, a synthetic fiber material or a natural strand.
5. The floating wave break apparatus of claim 1, wherein the flotation member is comprised of encapsulated expanded polystyrene.
6. The floating wave break apparatus of claim 1, wherein the lower edge of the wall members extends beneath the lower surface of the flotation member.
7. The floating wave break apparatus of claim 1, wherein the first and second side surfaces of the flotation member are each spaced apart from an adjacent wall member.
8. The floating wave break apparatus of claim 7, wherein the first and second side surfaces of the flotation member are spaced apart from the adjacent wall members forming a gap therebetween in the range of about 1 to 3 inches.
9. The floating wave break apparatus of claim 8, wherein wave action water after passing through the plurality of holes in the first wall member adjacent the flotation member is directed downward into the gap thereby dissipating wave action energy.
10. The floating wave break apparatus of claim 1, wherein a first floating wave break apparatus is connectable to a second floating wave break apparatus at a pivotal hinge.
11. The floating wave break apparatus of claim 1, wherein the at least one restraining member is four restraining members.
12. The floating wave break apparatus of claim 1, wherein the at least one winch drum is four winch drums with each winch drum rotatably mounted to a separate tower.
13. The floating wave break apparatus of claim 12, wherein each tower comprises a vertical leg and a canted leg with each leg mounted atop a partial cap.
14. The floating wave break apparatus of claim 1, wherein a third longitudinally extending wall member is spaced apart from the second longitudinally extending wall member and parallel to the first and second longitudinally extending wall members, the third longitudinally extending wall member further comprising first and second opposed planar surfaces, an upper edge a lower edge and opposed side edges, the third longitudinally extending wall member further comprising a plurality of through holes therein.
15. The floating wave break apparatus of claim 14, wherein the third longitudinally extending wall member comprises more through holes than the second longitudinally extending wall member and fewer than the first longitudinally extending wall member.
16. The floating wave break apparatus of claim 1, wherein the diameter of the through holes is in the range of about 6 to 10 inches.
17. The floating wave break apparatus of claim 16, wherein the first, second and third longitudinally extending wall members are spaced apart from one another in the range of about 23 to 27 inches.
18. A floating wave break apparatus to dissipate wave action in a body of water, the apparatus comprising: a plurality of parallel, spaced apart longitudinally extending wall members each comprising a plurality of through holes therein, upper and lower edges as well as first and second opposed side edges; a first end member mounted to the first opposed side edges of the wall members; a second end member mounted to the second opposed side edges of the wall members; at least one flotation member disposed between each of the spaced apart longitudinally extending wall members, the at least one flotation member comprising an upper surface, a lower surface and first and second laterally opposed side surfaces; at least one restraining member disposed above the at least one flotation member for restraining the flotation member against upward translation by buoyant forces; and an anchor system comprising at least one winch and rope combination, the

winch mounted to the upper restraining member and the rope with a first end secured to the winch and a second end secured to an anchor at the floor of the body of water, wherein the at least one winch and rope combination are adjustable to restrain movement of the wave break apparatus.

19. The floating wave break apparatus of claim 18, wherein each successive wall member after the wall member directly facing incoming waves comprises a fewer number of through holes than the previous wall member.

20. The floating wave break apparatus of claim 18, wherein the lower edges of the plurality of parallel, spaced apart wall members extends beneath the lower surface of the flotation member.

21. The floating wave break apparatus of claim 18, wherein the lower edges of the wall members extend downwardly beyond the lower surface of the flotation member.

22. The floating wave break apparatus of claim 18, wherein the first and second side surfaces of the flotation member comprise an outwardly extending flange proximate the upper surface of the flotation member.

23. The floating wave break apparatus of claim 22, wherein at least one fastener extends through the restraining member and engages with the outwardly extending flange to restrain the flotation member in position.

24. The floating wave break apparatus of claim 18, wherein the first and second side surfaces of the flotation member are spaced apart from each adjacent wall member.

25. The floating wave break apparatus of claim 24, wherein the first and second sides of the flotation member are spaced apart from each adjacent wall member by a distance in the range of about 1 to 3 inches.

26. The floating wave break apparatus of claim 25, wherein wave action water after passing through the plurality of holes in a first wave facing wall member adjacent the flotation member is directed downward beyond the lower surface of the flotation member upon impact with the flotation member thereby dissipating wave action energy.

27. The floating wave break apparatus of claim 26, wherein a portion of the wave action water after descending beyond the lower surface of the flotation member passes into the through holes of a next spaced apart wall member further dissipating wave action energy.

28. The floating wave break apparatus of claim 18, wherein a first longitudinally extending wall member absorbing the initial impact of the wave action comprises the greatest number of through holes of any wall member and each laterally displaced longitudinally extending wall member thereafter comprises fewer through holes for dissipating the wave action energy and incrementally reducing the velocity of the wave action of the body of water as confirmed by computational fluid dynamic modeling.

29. The floating wave break apparatus of claim 18, wherein the wall members comprise through hole diameters in the range of about 7 to 9 inches.

30. The floating wave break apparatus of claim 29, wherein the wall members comprise through holes of approximately 8 inches in diameter.