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(54) SAND AND SOIL INTERNAL REINFORCEMENT SYSTEM

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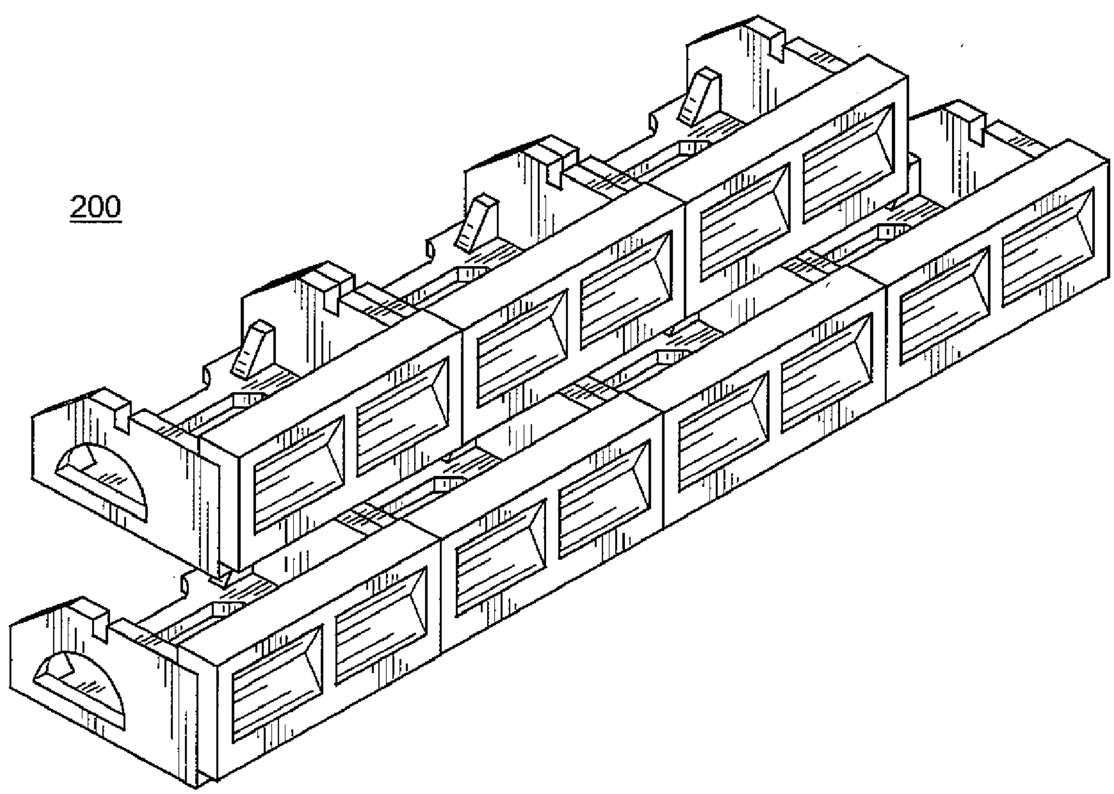
(57) **ABSTRACT**

A sand and soil internal reinforcement system including a plurality of individual modules removably connectable together act to reinforce sand and/or soil against shifting caused by erosive forces such as water and wind in high energy environments such as coastal beaches and watershed areas which produce large volumes of runoff or in hill sides subject to sliding due to ground water hydrostatic pressure. The modules include a cell having a front panel, rearward extending side walls which are held together by an open soil ballast and anchor membrane, and a refractor panel. Fill placed on top of the ballast and anchor membrane provides structural stability for each individual module independent of other adjoining modules of the reinforcement system. The interface established between adjacent modules requires no supplemental coupling devices, such as shear and alignment pins, to removably secure them together.



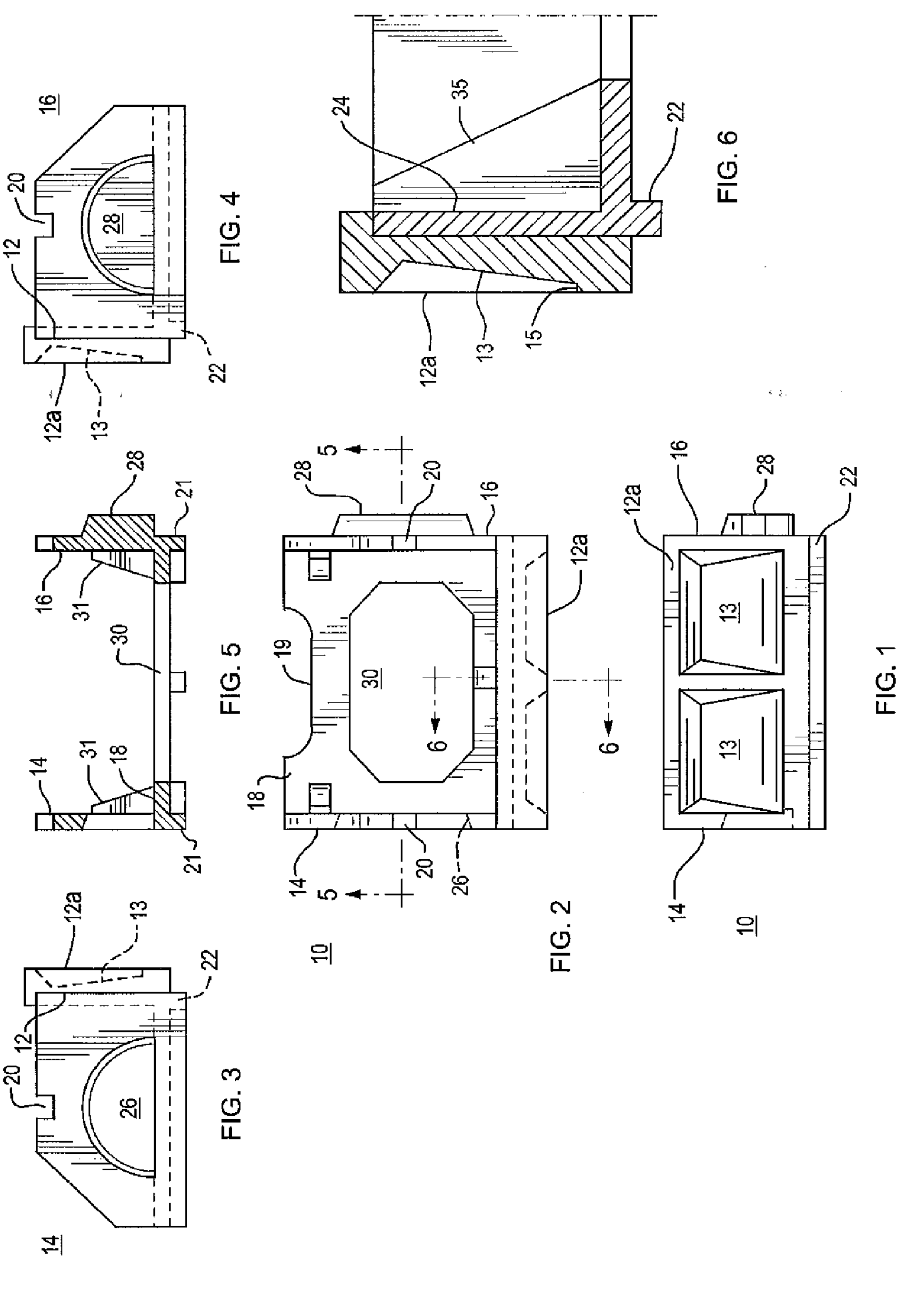


FIG. 1

FIG. 2

FIG. 3

FIG. 4

FIG. 5

FIG. 6

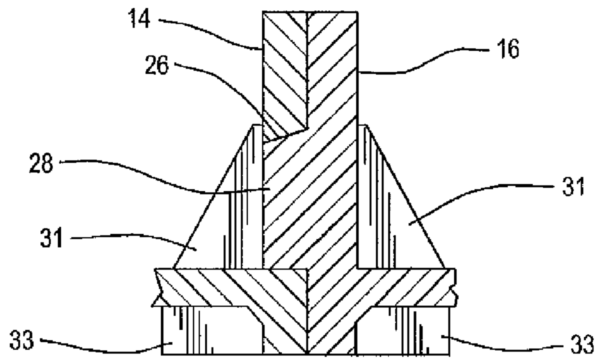


FIG. 7

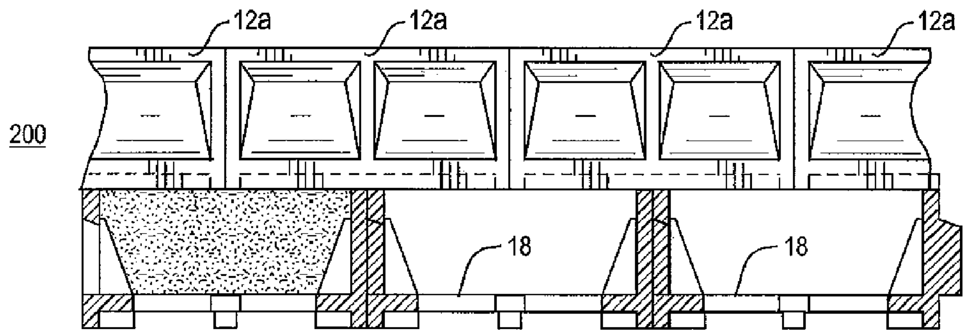


FIG. 10

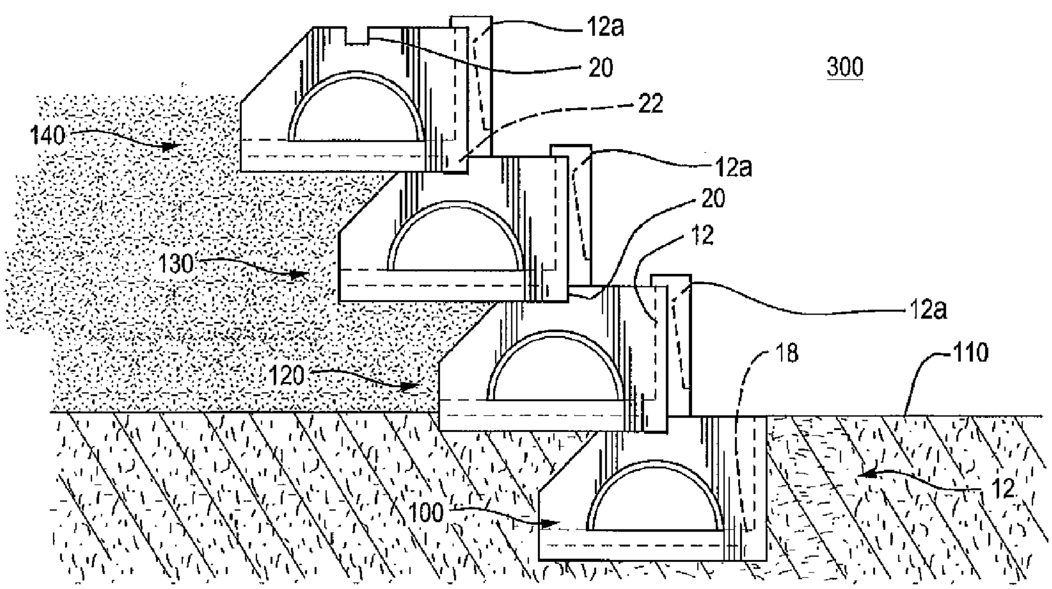


FIG. 11

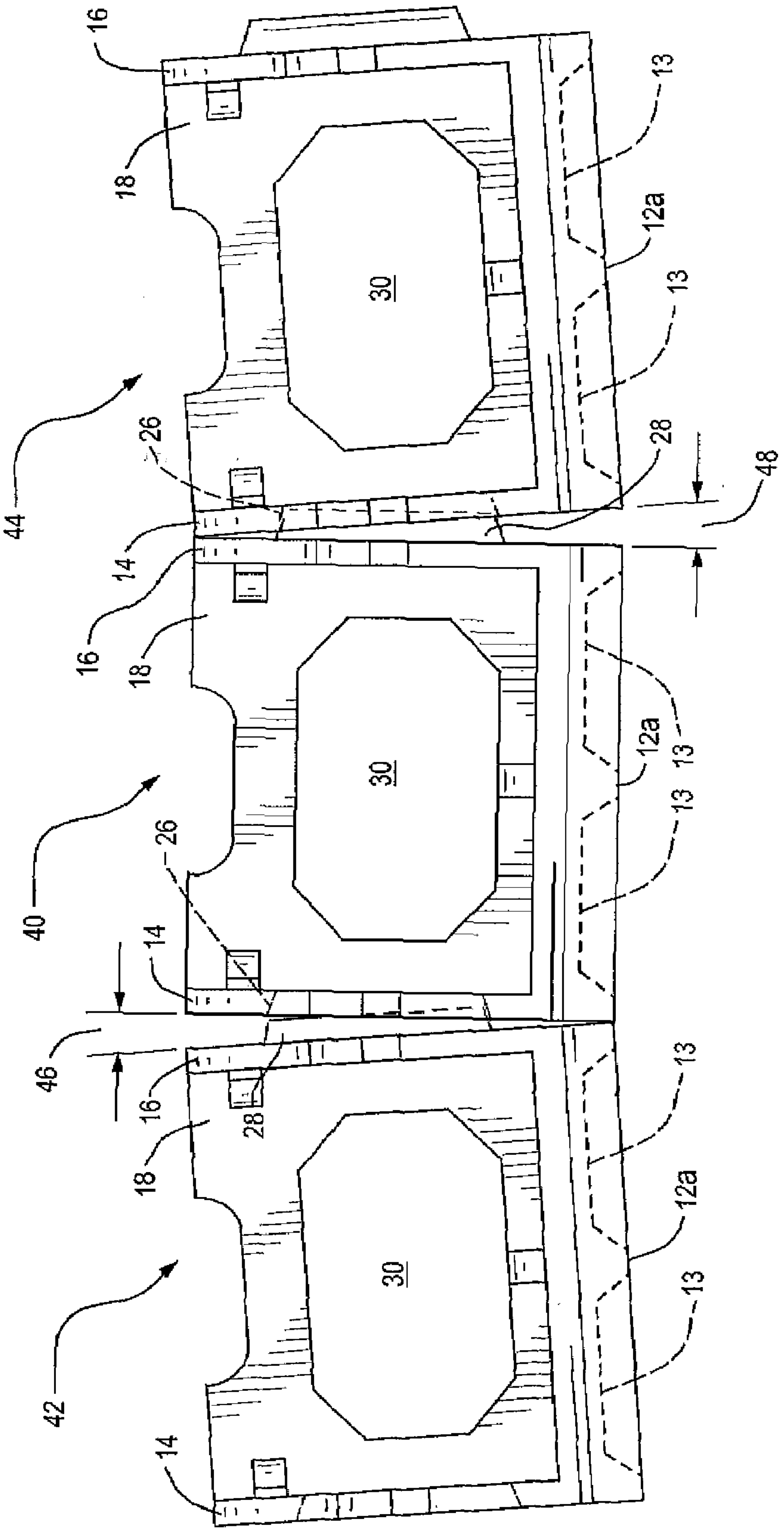

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FIG. 8

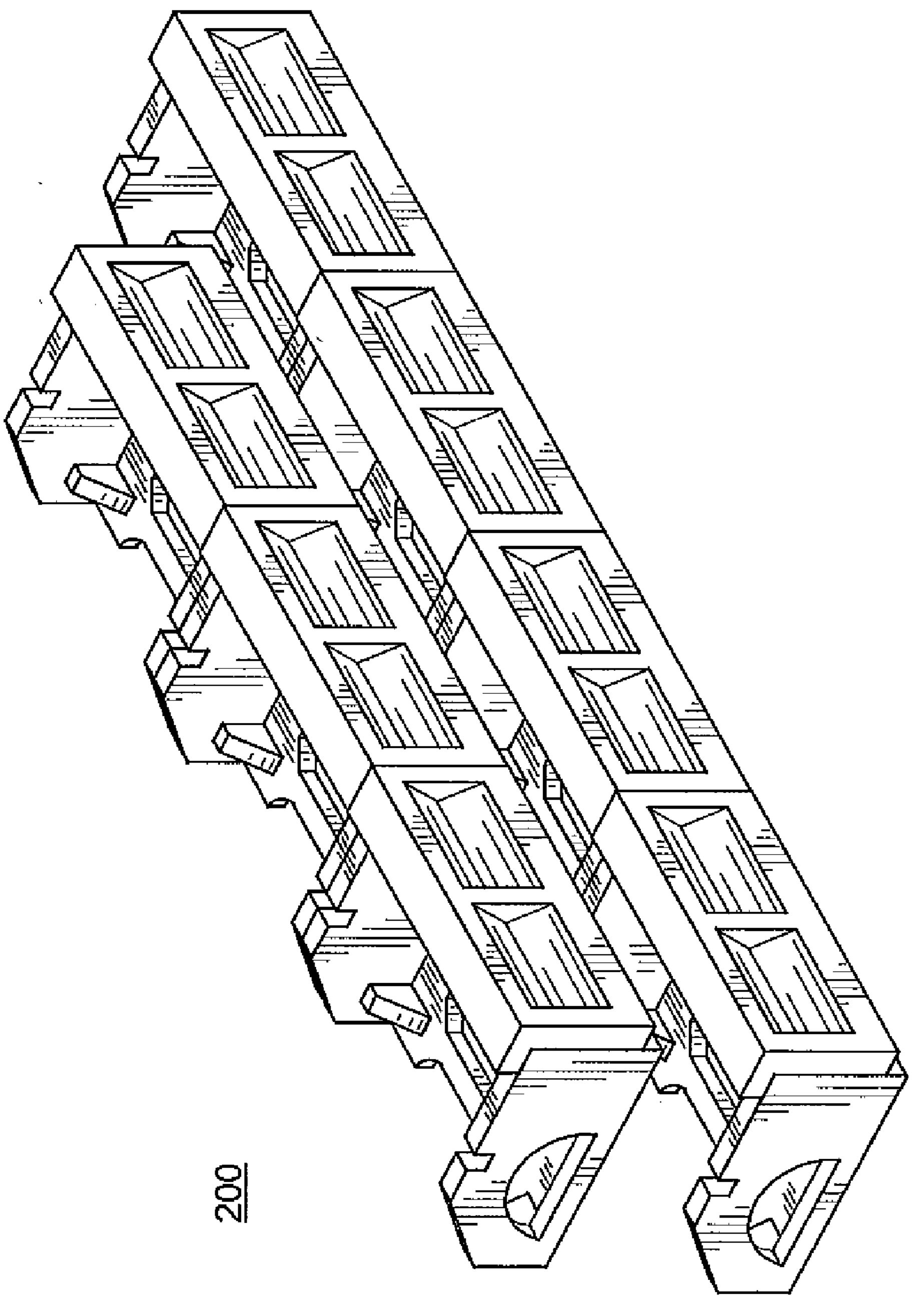

FIG. 9

SAND AND SOIL INTERNAL REINFORCEMENT SYSTEM

CROSS REFERENCE TO RELATED APPLICATION

[0001] The present application claims the priority benefit of U.S. provisional patent application Ser. No. 61/008,597, filed Dec. 20, 2007, entitled "SAND/SOIL CELL MODULE SYSTEM" of the same named inventor. The entire contents of that prior application are incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of Invention

[0003] The present invention relates to systems designed to reinforce the inherent structural characteristics of a body of sand or soil to assist in the resistance against erosive action. More particularly, the present invention relates to modular structures that may be selectable configured to conform with the geography, geology and contour of the location where the sand or soil to be reinforced exists. The present invention may be arranged as a plurality of modules establishing a multi-tiered system that when buried or otherwise integrated with the sand/soil, increases the tensile strength of the sand/soil strata, which would otherwise be weakened by super saturation, hydrostatic pressure, movement, shaking and/or shifting/sloughing by the dynamic forces of water, wind and/or earth tremors.

[0004] 2. Description of the Prior Art

[0005] Problems associated with sand and/or soil due to erosive wave attack or scouring by rapidly moving water in the coastal and inland environment are described in U.S. Pat. No. 5,499,891 ('891 patent) issued Mar. 19, 1996, by the inventor of the present invention. The entire content of the '891 patent is incorporated herein by reference.

[0006] The '891 patent describes an earth retaining system forming what is generally perceived as a wall constructed of a plurality of pre-cast concrete blocks with fill spaces. The wall requires assembly in place, with individually blocks joined and secured with shear and alignment pins, which shear and alignment pins may be coated with a protective non-metallic material, such as neoprene. The system of the '891 patent required off-site manufacturing of the wall components and then shipment of the components to the site of interest for placement, thereby requiring heavy construction machinery. The wall is intended to be arranged to create a terrace-type infrastructure, which is buried or can remain uncovered.

[0007] The structural stability of the '891 patented system is derived primarily by the mass of concrete of each block consisting of a front panel and side panels. It has been determined that there are limitations of design associated with the use of heavy concrete blocks fabricated and arranged in the manner described in the '891 patent. The individual blocks of the prior system, when aligned side by side, are limited in the formation of a curve such that gaps between individual blocks cannot be avoided while also establishing the required curvature. These gaps, created between the vertical side panels of adjacent blocks, result in the washout of sand or soil as water or wind forces pass over and, eventually, through the prior retaining system.

[0008] In addition to the existence of interblock gaps, the prior system has solid rearward extending side panels, which in conjunction with dead-man anchors provide stability, depending primarily on weight of the block. That arrangement is intended to maintain the system in place under the loading conditions anticipated, but make the system difficult to maneuver in place without substantial moving equipment, which may be difficult to bring to the location requiring the erosion stabilization. The prior system also requires the use of steel rods to anchor the blocks in place to prevent sliding. Sufficient anchoring may not be available, dependent upon the stability and retaining capability of the underlying substrate. Alternatively, it may be necessary to supplement standard anchoring rods with extensions, supplemental footings or the like to reach suitable substrate support, such as underlying bedrock well below the surface where the erosion occurs.

[0009] A further limitation of the prior retaining system described in the '891 patent is the existence of governmental restrictions on the introduction of concrete structures on public land, particularly in coastal locations. Prior alternatives to address the desire to eliminate concrete structures from public lands has led to the option of using less dense materials to form the modules, such as plastics, for example. However, prior plastic-fabricated retaining structures had to be assembled on site and then filled with sand/soil to establish the necessary load integrity. It is not particularly desirable to undertake assembly activity on site, particularly when that site is a public setting, such as a coastal beachfront. Moreover, the process of assembly can be costly in itself.

[0010] When concrete structures are permitted, if the placement site is difficult to access, it may be necessary to pour the structure on site. That then requires a time delay as the concrete sets up. In that situation, the process is slow and the curing concrete may be exposed to the damaging environmental conditions it is intended to blunt. A better system would involve the use of preassembled components easily installed at the location of need and ready for use once installed.

[0011] These and other features of the prior retaining systems limit their capability to provide an effective, cost efficient and marketable device suitable and competitive in the art of mitigating and preventing beach erosion and the failure of soil in embankments or bluffs. What is needed is a sand and soil internal reinforcement system configured to resolve these limitations.

SUMMARY OF THE INVENTION

[0012] It is an object of the present invention to provide a sand and soil internal reinforcement system that may be easily installed at any location of interest. Further, it is an object of the present invention to provide such a system that does not require the use of heavy machinery for either assembly or installation. Yet further, it is an object of the present invention to provide a sand and soil reinforcement system that allows for customized configuration formation without compromising its functionality including, for example, allowing for curved arrangements without modular gaps sufficient to compromise the integrity of the system.

[0013] These and other objects are achieved with the present invention, which is a sand and soil internal reinforcement system including a plurality of individual modules that when releasably coupled together in varied combinations through the linking of adjoining flexible slip joints form a multi-tiered, step-up, set-back, staggered and interlocked internal method to reinforce sand/soil against shifting, sloughing and other erosive action caused by water and wind in high energy environments such as coastal beaches and watershed areas which produce large volumes of runoff or in hill sides subject to sliding due to ground water hydrostatic pressure. In effect) the system of the present invention functions somewhat like a root system that one might expect from the existence of a trees and/or vegetation, which acts to reinforce the sand or soil associated therewith.

[0014] The modules of the system of the present invention are in a selectable geometric form, such as an open rectangular shape, for example, when viewed from above. The module includes a cell body and a refractor panel. The cell body includes a front panel, rearward extending side walls, and a ballast and anchor membrane, slightly raised above the bottom of the vertical components of the cell. The cell body is open on the top so that fill may be placed on top of the ballast and anchor membrane to provide structural stability for each individual cell module independent of other adjoining cell modules. The refractor panel may be removably or permanently affixed to the front panel of the cell body.

[0015] The side walls of each cell are configured to establish interface joints between adjacent cells. The interface joints established eliminate the need to use shear and alignment pins to secure adjacent cells together. Cells may be easily joined and separated due to the interface joints of the present invention. In an embodiment of the invention to be described herein, one of the two side walls of the cell body include a slip-type joint component and a protruding extension with a flat bottom and tapered surface. The opposing side wall includes an opening generally corresponding in configuration to the configuration of the protruding extension such that adjacent cell modules will fit together. One side wall acting as a male component and the adjacent side wall of the adjacent cell module acting as the female component when the two adjacent cell modules are positioned together. Each cell of the module is loaded with sand/soil fill placed on top of the ballast and anchor membrane and is anchored against sliding by, in addition the interface between adjacent cells, the ballast fill passing through an opening in the center of the ballast membrane to form a solid vertical column of sand/soil.

[0016] The modules may be combined in a multi-row setback, staggered stacked formation through interlocking placement at a bottom center point of the front panel of each upper cell into top alignment notches of the side panels of two adjoining lower cells. The stress of weight of the upper cell is distributed over the top of the underlying cells by both the interlocking portion of the front panel and also the underside of the soil ballast membrane.

[0017] The reinforcement system of the present invention comprising a plurality of the modules is set in place by burying it inside the toe of a coastal bank, dune, cliff or bluff. Its primary function is to provide a second line of defense during severe coastal storms or intense precipitation generating large amounts of runoff. Unlike any other system used to address erosion problems, the present invention, after it becomes partially or filly exposed during a severe wave attack, has the ability to dissipate the wave energy and decelerate the velocity of the moving mass of water. Specifically, one or more setback rows of a plurality of modules shear the volume of water pushed by an incoming wave into one or more horizontal layers depending on the height of the wave.

[0018] The dynamic energy of the moving mass of water is divided as it reaches the refractor panels of each module of a multi-tiered, step-up, set-back and interlocked system of the present invention, with the dividing events separated by microseconds. During that event delay measured in microseconds when the incoming wave is sheared into horizontal layers to create shear planes within the body of water, the shear planes themselves dissipate energy due to the friction generated. The volume of water between the shear planes after making contact with the refractor panels of the modules of the lowest row of the reinforcement system is lifted upward by the configuration of the refractor panel, which in an embodiment is backward inclined and recessed. The underside of the wave shear bar, located at the top of the refractor panel, reverses the flow of the water, pushing it into the underside of the upper flowing mass of water between the shear planes, effectively dissipating the dynamic energy by decelerating the wave velocity. The remaining scouring forces are directed upward and sideways away from the dune or upland, which are protected by the system. The turbulence created by the sudden stoppage of the moving mass of water occurs in mid air, effectively dissipating the scouring forces, minimizing the wave return velocity and preventing bottom scour.

[0019] These and other advantages of the present invention can be seen in the following detailed description, the accompanying drawings and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] FIG. **1** is a front view of a module of the reinforcement system of the present invention.

[0021] FIG. **2** is a plan view of the module of FIG. **1**.

[0022] FIG. **3** is a first side view of the module of FIG. **1**.

[0023] FIG. **4** is a second side view of the module of FIG. **1**.

[0024] FIG. **5** is a cross sectional front view of the module of FIG. **1**.

[0025] FIG. **6** is a cross sectional side view of the module of FIG. **1**.

[0026] FIG. **7** is a cross sectional partial front view of an intermodular interface of the reinforcement system of the present invention.

[0027] FIG. **8** is a plan view of a combination of interlocked modules of the reinforcement system of the present invention.

[0028] FIG. **9** is a perspective view of a first embodiment of the reinforcement system of the present invention.

[0029] FIG. **10** is a front view of the reinforcement system of FIG. **9**.

[0030] FIG. **11** is a side view of a second embodiment of the reinforcement system of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0031] The present invention is a sand and/or soil internal reinforcement system as illustrated in the accompanying drawings. The reinforcement system is a combination of individual modules that may be combined to form an interlocked and terraced arrangement of selectable configuration to internally reinforce sand and soils in coastal banks, dunes, beach berms, cliffs, bluffs, dikes, levees, and to effectively mitigate erosion caused by wave action, wind forces, hydrostatic pressure, super saturation and liquefaction. An important aspect of the invention is the configuration of a module **10** shown in FIGS. **1-6**.

[0032] The module **10** includes a cell body with a front panel **12**, a first side panel **14**, a second side panel **16** and a bottom ballast and anchor membrane **18**. The first side panel **14** and the second side panel **16** extend rearward from the front panel **12** and may be formed integrally with the front panel **12** or by separate components removably or permanently affixed to the front panel **12**. Further, the first side panel **14** and the second side panel **16** each include a top and a bottom areas of both the first side panel **14** and the second side panel **16** are joined together by the ballast and anchor membrane **18**. They may be removably or permanently joined to the membrane **18**. One or more of the front panel **12**, the first side panel **14**, the second side panel **16** and the membrane **18** may be formed as a unitary structure or as individual structures joined together.

[0033] The module **10** further includes a refractor panel **12***a* that is permanently or removably joined to the front panel **12** of the module **10**. The refractor panel **12***a* may extend above and cover a top portion of the front panel **12**. As shown in the figures, an upper region of the refractor panel **12***a* is a flange that is positioned on an upper forward surface of the front panel **12**. The upper flange of the refractor panel **12***a* may extend rearwardly along the upper forward surface of the front panel **12***a* selectable distance. The refractor panel **12***a* may be added to or removed from the cell of the module **10** as desired prior to module fill. The refractor panel **12***a* may be a separate structure to the cell body or it may be fabricated integrally therewith.

[0034] The refractor panel **12***a* includes one or more angled recesses **13**. The recesses **13** are preferably angled rearwardly from a perimeter frame of the refractor panel **12***a,* with the recess deeper at the upper portion of the refractor panel **12***a* than at the lower portion of the refractor panel **12***a*. This arrangement enhances wave shearing action upon first contact of a wave or other erosive actor so as to dissipate the energy of that action upon initial contact with the module **10**. The refractor panel **12***a* may further include an anti-scouring lip **15** at a lower portion thereof. The anti-scouring lip reduces the scouring effect of particulates that may be entrained in the fluid impacting the cell module **10**. The refractor panel **12***a* further includes beveled edges to redirect scouring forces in an upward and sideway direction. The refractor panel **12***a* may optionally be coated with a friction-reducing coating selected to resist scouring forces and atmospheric corrosive elements.

[0035] The cell and the refractor panel **12***a* of the module **10** may be fabricated of the same non-metallic material, such as a polymeric material. The refractor panel **12***a* may be coated to reduce the roughness coefficient of its surface so that scouring of that surface may be minimized. The cell may be an uncoated structure having a roughness coefficient approximating that of sand but not restricted thereto. With the refractor panel **12***a* substantially covering the portion of the cell most likely to come in direct contact with the most erosive action. This arrangement of the refractor panel **12***a* with respect to the front panel **12** and the remainder of the cell embeds the entire cell in the sand/soil and also covers interlocking notches of adjoining modules as shown in FIGS. **9** and **10**. It is also to be noted that the refractor panel **12***a* acts to minimize the strongest form of erosive forces on the cell of the module **10**. It is to be noted that with the two-piece arrangement of the module **10**, any damage is likely to occur at the refractor panel **12***a,* which may be replaced without the need to replace the entire module **10**. this arrangement, embeds the entire Cell Body in Sand and also covers the interlocking notches below the wave refractor panel.

[0036] Each of the first side panel **14** and the second side panel **16** includes a notch **20** at the top areas thereof and footings **21** at the bottom areas thereof. The notches **20** are adapted to accept in an interlocking manner bottom flange **22** of the front panel **12** substantially centered thereat. In this way, one cell module may be removably positioned on top of a pair of other cell modules by inserting the bottom flange **22** into adjacent notches **20**. The location of the notches **20** front to back on top of the side panels **14/16** is determined by the characteristics of the substrate to be retained and stabilized by the module **10**. Those characteristics include, but are not limited to, the shear stress of the substrate pressing against internal surface **24** of the front panel **12** when in position, and also the existing slope gradient of the coastal bank, dune or cliff at the stabilization location of interest. In particular, the angle of repose of a particular set of modules **10** is defined by differing locations of the notches **20**. That angle of repose is preferably selected to parallel the angle of repose of the particular soil type to be reinforced. In effect, the selected angle of repose is chosen to negate loading forces directed against the internal surface **24** of the front panel **12**.

[0037] The first side panel **14** includes a receiving port **26** that may be configured as a half-round tapered opening with a flat bottom. The second side panel **16** includes an interface protrusion **28** that is configured to correspond in design to the receiving port **26** of the first side panel **14** such that it fits within the receiving port **26** but with a loose fit between the two to allow for movement of one module in relation to an adjacent module without the interface protrusion **28** and the receiving port **26** completely separating from one another. For example, the dimensions of the receiving port **26** may be greater than the dimensions of the protrusion **28**. In the configuration of the module **10** shown in FIGS. **3-5**, the interface protrusion **28** is a half-round tapered extension with a flat bottom.

[0038] As shown in FIG. **7**, when two adjacent ones of the module **10** are to be removably interlocked together, the protrusion **28** of one module is inserted into the receiving port **26** of the other. Those two components of the module **10** are fabricated with sufficient difference in the respective dimensions of the protrusion **28** and the receiving port **26** that one module **10** may be angled with respect to the other without the protrusion **28** of that module being completely spaced away from the receiving port **26** of the other module. The flexible joint established in this manner secures adjacent modules together without the need for any additional coupling devices including, for example, the shear and alignment pins of the prior system described herein. The flexible joint established by the interface of the receiving port **26** of one module **10** with the protrusion **28** of an adjacent module **10** accounts not only for horizontal deflections of a system of modules, but also for vertical deflections, such as uplifts, as well. Further, and more specifically, the flat bottoms of the receiving ports **26** and the protrusions **28** establish both vertical and horizontal alignment of adjoining modules.

[0039] One or more of the side panels **14/16**, front panel **12**, and membrane **18** include reinforcement ribs and/or supporting cleats to equalize the dead weight of the fill and prevent side panels **14/16** from deforming. The reinforcement ribs associated with the side panels **14/16** also minimize or eliminate splaying of those panels during the fill operation, and further function as anchor elements to prevent forward and/or backward sliding of the cell body after embedment in sand or soil. Examples are shown in FIGS. **2** and **7** of a reinforcement rib **31** and a support cleat **33** for the side panels **14/16**. An example of a front panel reinforcement rib **35** is shown in FIG. **6**.

[0040] The thickness of the protrusion **28** and the depth of the receiving port **26** must be sufficient to allow the two to remain interfaced when one is moved with respect to the other. For example, FIG. **8** illustrates a row of three modules adjacent to one another. Center module **40** has a first alignment, second module **42** has a second alignment, and third module **44** has a third alignment, wherein each alignment is distinct from the others. The second module **42** is angled slightly forward with respect to the center module **40** and the third module **44** is angled in a more pronounced manner but in a rearward direction from the center module **40**. In this arrangement, first module interface **46** established by the joining of the protrusion **28** of the center module **40** and the port **26** of the second module **42** exists, but the protrusion **28** of the center module **40** extends at an angle slightly outwardly from the port **26** of the second module **42** at the rear thereof. A gap thus exists between the center module **40** and the second module **42**, but at the rear of the row of modules. In addition, second module interface **48** established by the joining of the protrusion **28** of the third module **44** and the port **26** of the center module **40** exists, but the protrusion **28** of the third module **44** extends at an angle slightly outwardly from the port **26** of the center module **40** at the front thereof A gap thus exists between the center module **40** and the third module **44**, but at the front of the row of modules. Maintenance of module interfaces while allowing for gaps between adjacent modules permits the user to customize the shape of the reinforcement system of the present invention by selective positioning of individual modules with respect to one another while keeping adjacent ones interlocked.

[0041] The bottom ballast membrane **18** illustrated in FIGS. **2** and **8** includes a cutaway section **19** and fill opening **30**. The cutaway section **19** and the fill opening **30** allow for fill to pass around and under the module **10** so as to enhance anchorage of the module **10** in the location of interest. The membrane **18** may be fabricated of any material considered to be suitable for the intended purpose including, but not limited to, a non-metallic material. The membrane **18** itself may be solid or porous but should be of sufficient strength to maintain the spacing between the first side panel **14** and the second side panel **16**. The inner space of the cell module **10** defined by the arrangement of the front panel **12**, the first side panel **14**, the second side panel **16** and the membrane **18** may be partially or completely filled with sand/soil to provide enough ballast to the cell module **10** so that it becomes substantially immovable once positioned where desired.

[0042] The loaded membrane **18** together with the bottom flange **22** of the front panel **12** and the footings **21** of the first side panel **14** and the second side panel **16**, once the cell module **10** is filled, establish a solid footing for each module independent of the condition of any adjoining modules. Further, the cell module **10** is configured so that any portion of the fill within the open space of the cell module **10**, when exposed to attack by plunging type waves, will cause saturation of the fill strata directly behind the front panel **12**. The top of the ballast membrane **18** and the volume of any dry fill within the cell module **10** will hold the saturated fill in place, allowing excess content of water to be absorbed into the mass of dry fill without being blown out and causing a void in the embedment fill.

[0043] The cell module **10** may be fabricated of high strength geo-synthetic polymer or similar non-metallic material, provided it is sufficiently resistive to atmospheric corrosive elements. The use of a non-metallic material provides sufficient strength of the structure while maintaining relatively lightweight. The cell module **10** derives its stability mainly from the fill placed on the ballast membrane **18** rather than from the structure itself which was a limitation of the prior stabilization devices. When a plurality of cell modules **10** are positioned adjacent to and on top of one another, a terraced-type soil and sand internal reinforcement system is established, such as system **200** shown in FIGS. **9** and **10** in a two-tier arrangement, and as system **300** in FIG. **11** in a four-tier arrangement. In the four-tier arrangement, an anchor tier **100** is first positioned below existing grade **110** and each cell module thereof filled. A second tier **120** is then positioned set back on the anchor tier **100**, with the bottom flanges **22** of the front panels **12** inserted into the notches **20** of the side panels **14/16** of the cell modules of the anchor tier **100**. The cell modules of the second tier **120** are filled and a third tier **130** is then positioned set back on the second tier **120**, with the bottom flanges **22** of the front panels **12** inserted into the notches **20** of the side panels **14/16** of the cell modules of the second tier **120**. The cell modules of the third tier **130** are filled and a fourth tier **140** is then positioned set back on the third tier **130**, with the bottom flanges **22** of the front panels **12** inserted into the notches **20** of the side panels **14/16** of the third tier **130**. Finally, the cell modules of the fourth tier **140** are filled and the surrounding sand/soil graded as desired.

[0044] The tiered arrangement of cell modules of the present invention, of which FIGS. **9-11** represent examples, create a sand and/or soil internal reinforcement system that increases the effective tensile strength of the sand/soil and that can be formed without the need for heavy moving equipment. The system has the capacity to be penetrable by sand/soil and water and enables the release of hydrostatic pressure. The cell modules may be configured and arranged such that at no point within the vertical rise of the multi-tiered reinforcement system does the hydrostatic pressure exceed one pound per square inch, regardless of the number of tiers. The horizontal tiers may be extended selectively to widen the overall footprint of the system so that the energy of plunging-type waves is uniformly absorbed by the mass of sand/soil where the system is located.

[0045] It is to be noted that the reinforcement system also forms horizontal terraces, which after exposure by wave or wind action, may remain uncovered and is thereby suitable to establish separate planter boxes for native coastal vegetation. Further, the arrangement of the multi-tiered reinforcement system, upon exposure after aggressive wave action, can be traversed by pedestrians without difficulty. More generally and as earlier noted, the present invention is advantageous in that the modules may be arranged at angles with respect to one another such that curved and other complex shapes of the reinforcement system may be created, particularly to conform with the condition of the environment where the internal reinforcement is required. The modules are lightweight and can therefore be manually transported and set in place. They do not require additional coupling components to establish a multi-tiered reinforcement system such as, but not limited to, coated shear pins for alignment.

[0046] One or more example embodiments to help illustrate the invention have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the invention. Accordingly, other embodiments are within the scope of the claims appended hereto.

What is claimed is:

1. A sand and/or soil internal reinforcement system comprising a plurality of modules selectable arranged and removably interlocked with one another, wherein two or more of the modules each includes:

a. a front panel;

b. a first side panel joined to the front panel, wherein the first side panel includes a receiving port of selectable configuration;

c. a second side panel joined to the front panel and spaced from the first side panel by the front panel, wherein the second side panel includes a protrusion configured to match substantially the configuration of the receiving port of the first side panel; and

d. a bottom ballast and anchor membrane joined to the first side panel and the second side panel, further spacing the first side panel from the second side panel, wherein the internal reinforcement system is established by inserting the protrusion of one or more modules into the receiving port of one or more adjacent modules and filling one or more modules with fill placed on the bottom ballast and anchor membrane.

2. The system as claimed in claim **1** further comprising a refractor panel located on the front panel, wherein the refractor panel is arranged to refract erosive forces.

3. The system as claimed in claim **2** wherein the refractor panel includes one or more angled recesses in order to further divide erosive forces applied to the refractor panel.

4. The system as claimed in claim **3** wherein the refractor panel further includes beveled edges to redirect scouring forces in an upward and sideway direction.

5. The system as claimed in claim **3** wherein the angled recesses are angled rearwardly from a perimeter frame of the refractor panel.

6. The system as claimed in claim **2** wherein the refractor panel is coated with a friction-reducing coating selected to resist scouring forces and atmospheric corrosive elements.

7. The system as claimed in claim **2** wherein the face of the refractor panel includes a scouring lip.

8. The system as claimed in claim **1** wherein the plurality of modules are oriented in a multi-tiered arrangement.

9. The system as claimed in claim **5** wherein one of the tiers of the multi-tiered arrangement is an anchor row positionable below the grade of the area where sand and/or soil is to be reinforced.

10. The system as claimed in claim **1** wherein the receiving port of the first side panel is configured as a half-round tapered opening and the protrusion of the second side panel is configured as a half-round tapered extension.

11. The system as claimed in claim **10** wherein the dimensions of the half-round tapered opening are greater than the dimensions of the half-round tapered extension.

12. The system as claimed in claim **1** wherein each of the first side panel and the second side panel includes a notch at a top surface thereof, wherein the notch is configured to receive therein a bottom flange of the front panel and determines the angle of repose of a frontal face of the multi-tiered arrangement.

13. The system as claimed in claim **1** wherein the bottom ballast membrane includes a fill opening arranged to permit fill to pass therethrough to form an uninterrupted vertical column of sand and/or soil.

14. The system as claimed in claim **1** wherein one or more portions of the module are made of non-metallic material.

15. The system as claimed in claim **14** wherein the non-metallic material is a geo-synthetic polymer.

16. A module suitable to facilitate the internal reinforcement of sand or soil located in an erosive environment, the module comprising:

a. a front panel;

b. a first side panel joined to the front panel, wherein the first side panel includes a receiving port of selectable configuration;

c. a second side panel joined to the front panel and spaced from the first side panel by the front panel, wherein the second side panel includes a protrusion configured to match substantially the configuration of the receiving port of the first side panel; and

d. a bottom ballast and anchor membrane joined to the first side panel and the second side panel, further spacing the first side panel from the second side panel.

17. The module as claimed in claim **16** further comprising a refractor panel located on the front panel, wherein the refractor panel is arranged to refract erosive forces.

18. The module as claimed in claim **17** wherein the refractor panel includes one or more angled recesses in order to further divide erosive forces applied to the refractor panel.

19. The module as claimed in claim **18** wherein the refractor panel further includes beveled edges to redirect scouring forces in an upward and sideway direction.

20. The module as claimed in claim **18** wherein the angled recesses are angled rearwardly from a perimeter frame of the refractor panel.

21. The system as claimed in claim **17** wherein the refractor panel is coated with a friction-reducing coating selected to resist scouring forces and atmospheric corrosive elements.

22. The module as claimed in claim **17** wherein the refractor panel includes a scouring lip.

23. The module as claimed in claim **16** wherein the receiving port of the first side panel is configured as a half-round tapered opening and the protrusion of the second side panel is configured as a half-round tapered extension.

24. The module as claimed in claim **23** wherein the dimensions of the half-round tapered opening are greater than the dimensions of the half-round tapered extension.

25. The module as claimed in claim **16** wherein each of the first side panel and the second side panel includes a notch at a top surface thereof, wherein the notch is configured to receive therein a bottom flange of the front panel.

26. The module as claimed in claim **16** wherein the bottom ballast and anchor membrane includes a fill opening.

27. The module as claimed in claim **16** wherein one or more portions of the module are made of non-metallic material.

28. The module as claimed in claim **27** wherein the non-metallic material is a geo-synthetic polymer.

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