ANCHORING GABION SYSTEM FOR EROSION CONTROL

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ABSTRACT
An artificial root system for gabions to control soil erosion has an anchor which has a nose cone threadable onto a threaded rod and deployable stainless steel blades. On deployment of one or more anchors on each of a series of rods, connectors are attached to the rods. These connectors have four couplers to receive the ends of threaded rods or bars, and a central coupler to receive one (passing through) or two (meeting) threaded rods or bars. Threaded cross bars or rods are attached to the connectors to form a framework to support geotextiles attached to the cross bars or rods to form a gabion, or gabion array. The gabions are then filled with suitable material, to repair, or replace eroded shoreline, river frontage, lake frontage, etc.
ANCHORING GABION SYSTEM FOR EROSION CONTROL


[0002] This application relates to an anchor, and anchoring gabion system and a method to counter or prevent soil erosion and the like. Soil erosion is prevented or reduced by reinforcing the soil subject to erosion, for example by a breakwater, sea wall, embankment, dyke, or similar construction. Sometimes this is done by proving a gabion or cage or basket full of erosion resistant material, sand, soil, stones, shingle, rocks, concrete and the like, which is intended to stabilize riverbanks, shorelines, or provide or replace embankments, reduce or prevent soil erosion for rivers, lakes and other bodies of water, recover eroded river frontage and lake frontage, and reinforce ditches at their sides. The gabion or cage or basket is more effective when anchored, as the greatest erosion is likely to occur at highest water flow, waves, current, scour or pressure (flood, tidal, storm, seasonal). Even anchored gabions have been moved by water flow. Typically the gabion structure extends outward from an already eroded shoreline, but as those skilled in the art appreciate it can be used, under suitable conditions to create jetties, breakwaters and the like.

BACKGROUND

[0003] As noted the major problem lies in anchoring the gabions. Typically four vertical rods, which may be tubular, are anchored at the points of a rectangle. Although squares, triangles, or other packing polygons may be used as would be understood by those skilled in the art, in general rectangles are used. Level cross bars, which may be tubular, are attached at the tops of the vertical rods, and geotextile material, reinforced matting or netting or textile, is attached to the vertical rods and cross bars which together with a base geotextile form a gabion gage, which is then filled with suitable material. The filled gabion or arrays thereof are usually covered with earth to mask or disguise the structure. Unless the anchors hold, part of, or the entire structure can move under the effect of high water flow, defeating its purpose.

[0004] The invention includes an anchor, with anchor blades, attachable to a reinforcing threaded rod, which together when drilled into the ground form a vertical rod. An array of vertical rods is connected by cross bars, identical to the vertical rods, but different in function, which engage connectors fitting onto the vertical rods. The connectors are designed to accept six threaded rods, including an optional upward extension of the vertical rod. Geotextile is then placed vertically between and touching the vertical rods and cross bars and clipped to the cross bars, while a base geotextile extends between the corner vertical rods. The gabion basket is then filled with suitable material. Optionally, a second layer of vertical rods, associated connectors and cross bars can be assembled to receive more geotextile to give a second layer of gabion baskets. The anchor basically comprises a threaded hole cone with four blades extending upward, one, two or even three anchors can be threaded onto a single vertical rod. The blades fit snugly against the rod, except at their ends which are flared outward. The vertical rod with its associated anchor(s) is thrust down into the hole drilled in the soil. On pulling upwards the blades open like an inverted umbrella forming an artificial root system to anchor the vertical rod in the soil. The more anchors the solidier the rod is anchored. The artificial root system of the invention holds the gabion array in place. The connectors consist of a central housing having four horizontal sockets, and a vertical socket. The horizontal sockets each contain a threaded coupler to receive a threaded cross bar. The vertical socket contains a either a single threaded coupler to receive a bottom threaded vertical rod, or optionally a top threaded vertical rod, or a single smooth coupler, in which case nuts are threaded on the rods to adjust connector height. The connectors may also be attached around a cross bar to allow a side angled rod and associated anchor to anchor the sides of the gabion array. A horizontal rod and associated anchor can be used to anchor a gabion to a bank or other vertical substrate, in which case the horizontal rod usually connects to a horizontal socket of a six way connector.

[0005] Although the invention is described and referred to specifically as it relates to specific anchors and connectors, structures embodying them, and methods of construction using them, for combating soil erosion, it will be understood that the principles of the invention are equally applicable to similar anchors, connectors, structures and methods for combating soil erosion, it will be also understood that the invention is not limited to such anchors, connectors, structures and methods for combating soil erosion.

PRIOR ART

[0006] Applicant is not aware of any closely related prior art.

[0007] It is a principal object of the invention to provide an artificial root system to anchor gabions to combat soil erosion. It is a further principal object to provide an improved deployable anchor for an artificial root system. It is a further principal object to provide an improved deployable anchor blade. It is a subsidiary object of the invention for the blade to have a tang adapted to engage the anchor, a central portion extending therefrom, and a terminal tip to resist soil motion. It is a further principal object of the invention to provide a nose cone to receive the deployable anchor blade. It is a further subsidiary object of the invention to provide slots in the nose cone to receive the tangs of the anchor blades. It is a further subsidiary object of the invention to provide a central threaded aperture to receive threaded rods in the nose cone. It is a further principal object of the invention to provide horizontal, vertical and angled anchor systems for a gabion system. It is a further principal object to provide a system of support rods threaded into the anchors to support a gabion system. It is a further principal object of the invention to provide a frame work of rods and bars, generally at right angles to other each other to support geotextiles and form a gabion system. It is a subsidiary object of the invention to provide improved connectors for the framework. It is a further subsidiary object to provide four couplers in the connector to receive ends of threaded rods or bars. It is a further subsidiary object to provide a central coupler in the connector to receive one (passing through) or two (meeting) threaded rods or bars. It is a further principal object of the invention to provide a method of constructing gabion (arrays). Other objects of the invention will be apparent to those skilled in the art from the following specification, appended claims and accompanying drawings.
DESCRIPTION OF THE INVENTION

[0008] In a first broad aspect the invention is directed to an anchor for an artificial root system comprising a nose cone and a deployable anchor blade attached to the nose cone, which has a central threaded aperture to receive a threaded rod. Preferably the blade has a tang receivable in a slot in the nose cone, and extending outward of the tang is a semicylindrical portion, convex side away from the threaded aperture. Preferably a pressure yield aperture is present at the join of the tang and the semicylindrical portion, whereby when sufficient force is applied to the semicylindrical portion the blade bends at the join of the tang and the semicylindrical portion. More preferably the semicylindrical portion has a convex strengthening rib running along its exterior, and a tip portion extends outward of the semicylindrical portion away from the central threaded aperture. Preferably the tang has a retainer aperture, and the nose cone has a radial pinning aperture aligned with the retaining aperture and a retaining pin in the radial pinning aperture engaging the retaining aperture of the tang. The nose cone preferably has an outward angled back stop plane to engage the blade when the blade is bent outward at the tang-semicylindrical join. This back stop plane may be angled nearly flat, say around 10°, but 45° is preferred. In especially preferred form the nose cone has four blades symmetrically arranged around the threaded aperture. The nose cone tapers away from the blades. Each blade has a tang receivable in a slot in the nose cone, and extending outward of the tang a semicylindrical portion, convex side away from the threaded aperture, with an exterior convex strengthening rib extending along the semicylindrical portion. A pressure yield aperture is present at the join of the tang and the semicylindrical portion, whereby when sufficient force is applied to the semicylindrical portion the blade bends at the join of the tang and the semicylindrical portion. A tip portion extends outward of each semicylindrical portion away from the central threaded aperture. Each tang has a retaining aperture. The nose cone has a radial pinning aperture aligned with each retaining aperture and a retaining pin in each radial pinning aperture engaging each retaining aperture of the tang. The nose cone has a separate outward angled back stop plane to engage each blade when each blade is bent outward at the tang-semicylindrical join. It should be noted that the number of blades is not restricted to four, but three or less, or five or more were less convenient to manufacture. In use the central threaded aperture engages a steel threaded rod. After construction the anchor is in a substrate and the blades are deployed outward to engage the substrate.

[0009] In a second broad aspect the invention is directed to a gabinion system comprising an array of vertical threaded rods, anchored in a substrate by anchors. Each anchor has having a nose cone with a central threaded aperture engaging the threaded rods, and a plurality of blades attached to the nose cone deployed outward to engage the substrate. Preferably each vertical threaded rod engages a six way connector by a central fixed coupler. The connector has four rotatable couplers symmetrical arranged around the central fixed coupler to engage threaded cross bars at their ends connecting the vertical threaded rods. Usually the six way connector has a housing, containing a central socket comprising a central fixed coupler, and four radial sockets comprising rotatable couplers. The radial sockets are cylindrical with a circumferential axle rib, the rotatable couplers being cylindrical with an external circumferential groove engaging the rib. The rotatable coupler has an interior threaded aperture to engage a threaded cross bar. Sometimes the central fixed coupler has an interior threaded aperture to engage a threaded vertical rod. Preferably the threaded cross bars engage the connectors to form at least one gabinion cage. Geotextiles are conveniently attached to the cross bars and depend downward to the substrate forming the walls of at least one gabinion cage. A geotextile lying on the substrate forms the base of a gabinion cage, and the downward geotextiles are clipped to the base geotextile to form the gabinion cage. On completion the gabinion cage is filled with suitable material.

[0010] In the third broad aspect the invention is directed to a method of construction of a gabinion cage system. First step is drilling an array of vertical holes. Then into each hole is inserted a vertical threaded rod, which engages an anchor having a central threaded aperture and deployable blades. The next step is deploying the blades to engage the substrate. When the vertical rods are ready, the additional step is performed of placing connectors having a central fixed coupler and four radial rotatable couplers on the vertical rod by passing the vertical rod through the central coupler, then the further step of levelling the connectors. Threaded cross bars are connected to the radial couplers to form at least one gabinion cage, then geotextiles are attached to the cross bars to form the walls of at least one gabinion cage, next a geotextile is laid to form the base of the at least one gabinion cage, and then the wall geotextiles are clipped to the base geotextile. Lastly the gabinion cages are filled with suitable material.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. 1 shows schematically a perspective view of a gabinion array of the invention.

[0012] FIG. 2 shows a more detailed end view of a gabinion of the invention.

[0013] FIG. 3 shows a sectional view of FIG. 2.

[0014] FIG. 4 shows a side view of an alternative anchor arrangement of the invention.

[0015] FIG. 5 shows a sectional side view of a six way connector of the invention.

[0016] FIG. 6 shows a top view of the connector of FIG. 5.

[0017] FIG. 7 shows a top view of a bottom housing of FIG. 5.

[0018] FIG. 8 shows an undeployed anchor of the invention.

[0019] FIG. 9 shows a deployed anchor of FIG. 8.

[0020] FIG. 10 shows a side view of an anchor blade of FIG. 8.

[0021] FIG. 11 shows an interior view (from the vertical rod) of an anchor blade of FIG. 8.

[0022] FIG. 12 shows a top end view of an anchor blade of FIG. 8.

[0023] FIG. 13 shows a side sectional view of a nose cone of FIG. 8.
FIG. 14 shows a top plan view of a nose cone of FIG. 8.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0025] The invention is now illustrated by reference to preferred embodiments thereof. Numerical 10 indicates a gabion array of the invention, which extends from uneroded land 12 at erosion scarp (new shoreline) 14 over eroded shore 16. A trench of suitable depth may be dug to accommodate the gabion array. Initially six foot vertical rods 18 are lowered into drilled 4 inch holes, one or more feet deep, with partly deployed anchors 20. Rods 18 are then raised about a foot fully deploying anchors 20, providing an artificial root system, as shown two anchors 20 are present on each vertical rod 18, each anchor 20 provides approximately 2500 lbs force resistance to movement. The holes must be deep enough to accommodate anchors 20 and allow their raising to deploy them. Six way connectors 22 are then threaded or slid onto vertical rods 18, and levelled. Base geotextiles 24 are then laid to form the base of each individual gabion. Longitudinal cross bars 26 and transverse cross bars 28 are then threaded into six way connectors 22. Each longitudinal cross bar 26 has passed over it longitudinal geotextile 30 and each transverse cross bar 28 has looped over it transverse geotextile 32, these loops forms channels through which cross bars 26 and 28 are passed. The bases of the geotextiles 30 and 32 are attached to base geotextile 24 by stainless steel clips 34. When frost is present anchors 20 must be below the frost line, in southern Manitoba, at least four feet below the final surface to prevent heaving. In FIG. 1, the individual gabions are ten feet long by five feet across by four or five feet deep. The gabions nearest the shore are filled with clean limestone, as is the slope outwards from gabion array 10 over eroded shore 16, the next two rows of gabions are filled with a mixture of gravel, mud and soil, the last row of gabions, next to eroded shoreline 12, is filled with soil. The gabions array and outer slope are then covered with seeded topsoil. Clean limestone adjacent the shoreline is an environmental requirement in some jurisdictions to provide shelter for fish fry. If necessary a second tier gabion array may be built on top of the first, and so on. The vertical rods and cross bars are % inch Dywidag tubular rods 40 feet long cut to size, the variety used are left hand thread, these are normal steel, and relatively cheap, compared to the right hand thread version which is high performance steel. Generally a gabion array is used, but occasionally a single gabion may be appropriate, for example in a ditch where only a single slat trench gabion may be possible.

[0026] In FIG. 2, gabion 11, has end vertical threaded rods 18 secured in pre-carved soil 36 by deployed anchors 20. Each rod 18 is levelled six way connectors 22, which receive transverse cross bar 28, which supports transverse geotextile 32, by passing through channel 38, formed by looping over geotextile 32 and attaching it to itself along seam 40 (as shown in FIG. 3). The bottom of geotextile 32 is secured to base geotextile 24 by stainless steel clip. Six way connector 42 can be mounted on longitudinal cross bar 26, to receive side angled threaded rod 44, identical in structure to rod 18, and bars 26, and 28. By thrusting angled rod 44 and anchor 46 into an angled hole then withdrawing rod 44, anchor 46 can be deployed forming a side anchor for the gabion. Although angle rod 44 is show supporting longitudinal bar 26, as those skilled in the art understand, it can support transverse bar 28, instead or as well as bar 26.

[0027] It is sometimes necessary, as in FIG. 4, to anchor the gabion array to a bank or other vertical substrate 48, in which case horizontal rod 50 and its anchor 52, are passed through a hole into bank 48 and anchor 52 is deployed by pulling outward, then connector 22 is attached to vertical rod 18 and cross bars 26 and 28 to support gabion array 10.

[0028] In FIGS. 5, 6 and 7, connector 22 has top housing 54 and bottom housing 56, top housing 54 has four right angled semicircular sockets 58, and central top socket 60. Sockets 58 extend 2½ inches from the center of the housing, have o.d. 1½ inch and i.d. 1⅞ inch except at axle rib 62, where it is 1½ inch. Sockets 58 are connected by flanges 64, whose outer edge is concave with 2½ inch radius, with ¼ inch rivet holes 66, which are 3⅜ inch in diameter square. Central top socket 60 has o.d. 1½ inch, central aperture of i.d. 1⅞ inch, the rest of the socket has an i.d of 1¼ inch. Bottom housing 56 has similar structure with four right angled semicircular sockets 68, connected by flanges 70 with ⅛ inch rivet holes 72, central socket 74 has integrally molded therein stationary coupler 76, which optionally may be threaded as shown in FIG. 5. When stationary coupler 76 is not threaded, a nut is placed beneath connector 22 on vertical rod 18 and rotated to level connector 22. When stationary coupler 76 accommodates cross bar (26 or 28), then nuts are placed on one or both sides according to need. Each semicircular socket 58 or 68 has therein axle rib 62, which engages axle groove 78 in rotating couplers 80, which are internally threaded. Stationary coupler 76 and rotating couplers 80 have i.d. 1¼ inch to accommodate Dywidag rods. The rotating couplers rotate so that one end of a threaded rod can be threaded into the coupler without unthreading another coupler at the other end of the rod. The rotating couplers project about 1½ inch to allow a wrench to be applied. All elements of the connector, except for stainless steel rivets, are of molded plastic, as those skilled in the art many such materials of suitable properties may be used in their manufacture, in practice 66 nylon is used.

[0029] In FIGS. 8 and 9, anchor 20 is shown deployed (FIG. 8) and deployed (FIG. 9), nose cone 82 engages four anchor blades (shovels or flukes) 84, which are secured within nose cone 82, on deployment blades 84 are forced downward and outward, extending up to about 2 feet across and exerting a resistant force of about 2500 pounds.

[0030] In FIGS. 10, 11 and 12, blade 84 is shown it has flat tang 86 for insertion into nose cone 82, cylindrical portion 88 with rib 90 extending the full length of cylindrical portion 88, rib 90 appears as grooves 90 in FIG. 11, and tip 92. Tang 86 has preferable retaining aperture 96 and pressure yield aperture 94. The entire blade is made of ¾ inch stainless steel. Tang 86 is 1⅞ inch long, ¾ inch wide, apertures 94 and 96 are ¾ inch diameter. Aperture 96 is ¼ inch from the end of tang 86. Cylindrical portion 88 has i.d. 1 inch, o.d. 1⅞ inch, and is about 1½ inch across, and ¾ inch deep, while rib 90 has i.d. ¼ inch and o.d. about ¾ inch. The cylindrical portion rises at an angle of 30° adjacent aperture 94, and extends about 9 inches to tip 92. Tip 92 has an angle of 45° to the rest of the blade and extends about 1¼ inch outward from the inside of cylindrical portion 88, ¼ inch outward from the outside of rib 90, and about 1⅞ inch.
upward from both, at its upper end it is ¼ inch wide. The entire blade as shown is about 11¼ inch long. It is important that the blade be of strong environmentally acceptable material, and thus stainless steel is preferred. The length is not critical, as it can be varied substantially depending on circumstance, and can be from six to twenty-four inches in length. Pressure yield aperture 94, allows blade 84 to bend to form the artificial root system. Retaining aperture 96 as discussed below is optional but preferred. Rib 90 has been found advantageous as it strengthens blade 84 significantly.

[0031] Nose cone 82 has bottom portion 98 with external walls angled outward at 76°, top portion 100 with external walls angled outward at 80°, central threaded aperture 102 in bottom portion 98, which receives threaded hollow rod 18. The external wall angles can be varied, however nose cone 82 should have inwardly and downwardly angled external walls. Bottom portion 98 also contains retaining slots 104 for blade tangs 86, which are intersected by pinning apertures 110, which receive retaining pins 106, which pass through retaining apertures 96 to hold blades 84 in place. Although blades 84 perform adequately in the absence of retaining pins 106, applicant has found that they perform better in their presence. Top portion 100 has 45° back stops 108 to receive blades 84 when deployed, other angles have been tested, notably a flatter angle of 13°, although anchors 100 performed adequately, sometimes blades 84 tended to pull down through the horizontal. Testing showed this did not occur with the 45° angle. Entire nose cone 82 is cast from 66 nylon. Applicant has found from tests that when vertical rod 18 is threaded into central threaded aperture 102, a force of 11,500 pounds was necessary for the nose cone to slip. Nose cone 82 is approximately 2½ inch deep, and 3½ inch across at its widest. As shown in FIG. 14, top portion 100 of nose cone 82 has a generally level or slightly concave surface 112. Spaced at right angles around central threaded aperture 102, are tang slots 104 outward of which are back stops 108. Optional annular recess 114 may surround central threaded aperture 102.

[0032] The threaded rods and bars used in the practice of the invention are left handed thread DYWDAG bars, the actual bars are 19(#6) grade 60, ⅝ inch diameter, which are tubular. The stainless steel used for blades and clips is 304 stainless steel, the commonest stainless steel as those skilled in the art are aware. The geotextiles used are Synteen SF 35 Geogrid, which are high molecular weight, high tenacity, multifilament polyester yarns woven into a stable network under tension, and then coated with PVC, they are inert to biological degradation and resistant to naturally encountered chemicals, alkalis and acids. Although these specific materials were used, there is no doubt that identical materials under different names, and similar materials can be used in stead.

[0033] As those skilled in the art would realise these preferred described details and materials and components can be subjected to substantial variation, modification, change, alteration, and substitution without affecting or modifying the function of the described embodiments. Although some components have been described above, including several specific optional features, it is not limited thereto, and it will be apparent to persons skilled in the art that numerous modifications and variations form part of the present invention insofar as they do not depart from the spirit, nature and scope of the claimed and described invention.

I claim:
1. An anchor for an artificial root system comprising a nose cone and a deployable anchor blade attached to said nose cone, said nose cone having a central threaded aperture to receive a threaded rod.
2. Anchor of claim 1, wherein said blade has a tang receivable in a slot in said nose cone, and extending outward of said tang a semicylindrical portion, convex side away from said threaded aperture.
3. Anchor of claim 2, wherein a pressure yield aperture is present at the join of said tang and said semicylindrical portion, whereby when sufficient force is applied to said semicylindrical portion said blade bends at the join of said tang and said semicylindrical portion.
4. Anchor of claim 3, wherein said semicylindrical portion has a convex strengthening rib running along said exterior, and a tip portion extends outward of said semicylindrical portion away from said central threaded aperture.
5. Anchor of claim 3 wherein said tang has a retaining aperture, said nose cone has a radial pinning aperture aligned with said retaining aperture and a retaining pin in said radial pinning aperture engaging said retaining aperture of said tang.
6. Anchor of claim 3, wherein said nose cone has an outward angled back stop plane to engage said blade when said blade is bent outward at said tang-semicylindrical join.
7. Anchor of claim 3 wherein said nose cone has four blades symmetrically arranged around said threaded aperture, said nose cone tapers away from said blades, each said blade has a tang receivable in a slot in said nose cone, and extending outward of said tang a semicylindrical portion, convex side away from said threaded aperture, a pressure yield aperture is present at the join of said tang and said semicylindrical portion, whereby when sufficient force is applied to said semicylindrical portion said blade bends at the join of said tang and said semicylindrical portion, and a tip portion extends outward of each said semicylindrical portion away from said central threaded aperture, and each said tang has a retaining aperture, said nose cone has a radial pinning aperture aligned with each said retaining aperture and a retaining pin in each said radial pinning aperture engaging each said retaining aperture of said tang, and said nose cone has a separate outward angled back stop plane to engage each said blade when each said blade is bent outward at said tang-semicylindrical join.
8. Anchor of claim 7, wherein said central threaded aperture engages a steel threaded rod.
9. Anchor of claim 8 wherein said anchor is in a substrate and said blades are deployed outward to engage said substrate.
10. Gabion system comprising an array of vertical threaded rods, anchored in a substrate by anchors, each having a nose cone having central threaded aperture engaging said threaded rods, and a plurality of blades attached to said nose cone deployed outward to engage said substrate.
11. Gabion system of claim 10, wherein each said vertical threaded rod engages a six way connector by a central fixed coupler, said connector having four rotatable couplers symmetrical arranged around said central fixed coupler to engage threaded cross bars at their ends connecting said vertical threaded rods.
12. Gabion system of claim 11, wherein said six way connector has a housing, containing a central socket comprising a central fixed coupler, and four radial sockets comprising rotatable couplers, said radial sockets being cylindrical with a circumferential axle rib, said rotatable couplers being cylindrical with an external circumferential groove engaging said rib, said coupler having an interior threaded aperture to engage a threaded cross bar.

13. Gabion system of claim 12, wherein said central fixed coupler has an interior threaded aperture to engage a threaded vertical rod.

14. Gabion system of claim 11, wherein threaded cross bars engage said connectors to form at least one gabion cage.

15. Gabion system of claim 14, wherein geotextiles are attached to said cross bars and depend downward to the substrate forming the walls of at least one gabion cage, wherein a geotextile lying on the substrate forms the base of a gabion cage, and said downward geotextiles are clipped to the base geotextile to form said gabion cage.

16. Gabion system of claim 15, wherein said at least one gabion cage is filled with suitable material.

17. Method of construction of a gabion cage system, comprising the step of drilling and array of vertical holes, then the step of inserting into each hole a vertical threaded rod, said threaded rod engaging an anchor having a central threaded aperture and deployable blades, and the further step of deploying said blades to engage said substrate.

18. Method of claim 17, comprising the additional step of placing connectors having a central fixed coupler and four radial rotatable couplers on the vertical rod by passing said vertical rod through said central coupler, and the further step of levelling said connectors.

19. Method of claim 18, comprising the additional step of connecting threaded cross bars to said radial couplers to form at least one gabion cage, and the further step of attaching geotextiles to said cross bars to form the walls of at least one gabion cage, then the further step laying a geotextile to form the base of said at least one gabion cage, and then the further step of clipping said wall geotextiles to said base geotextile.

20. Method of claim 19, comprising the additional step of filling said at least one gabion cage with suitable material.

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