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E1H

(71) Applicant
Ardon International Ltd (United Kingdom),
14 St John's Road, Tunbridge Wells, Kent, TN4 9NP

(72) Inventor
Edgar Gerald Wise

(74) Agent and/or Address for Service
E G Wise,
Ardon International Ltd, 14 St Johns Road, Tunbridge Wells, Kent TN4 9NP

(54) Improvements in or relating to a method of and device for use in preventing ground erosion and maintaining earth stability

(57) A Flexible Revetment Panel comprising a plurality of blocks 1 of a castable material interconnected by a two-dimensional mesh of cables 2 cast into the volume of each of said blocks said blocks being provided with chambers 3 cast therein and open-ended at least on a side of said block and extending partway into the volume thereof and in which said chamber an associated length of said cable comprising said mesh is free to deflect from the length of its longitudinal axis cast into said volume of said block. The plurality of blocks forming said panel may be cast either as separate blocks in a compound mould or alternatively may be formed after the casting of said panel by the fracturing of said panel along zones of controlled weakness formed in the process of casting said panel.

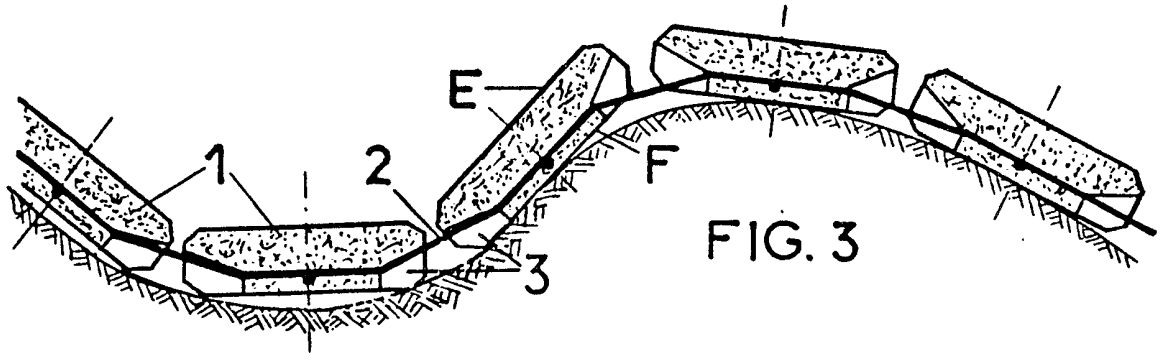

FIG. 3

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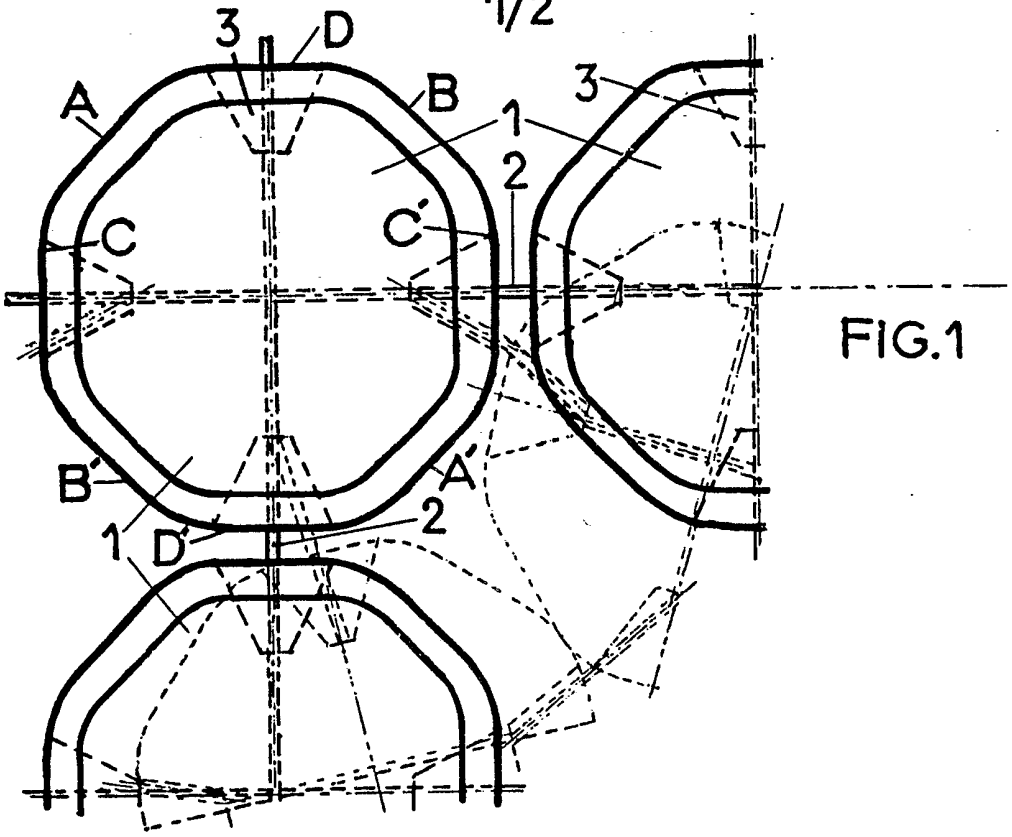

FIG.1

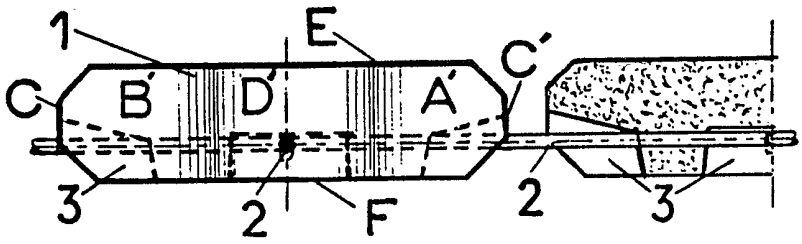

FIG. 2

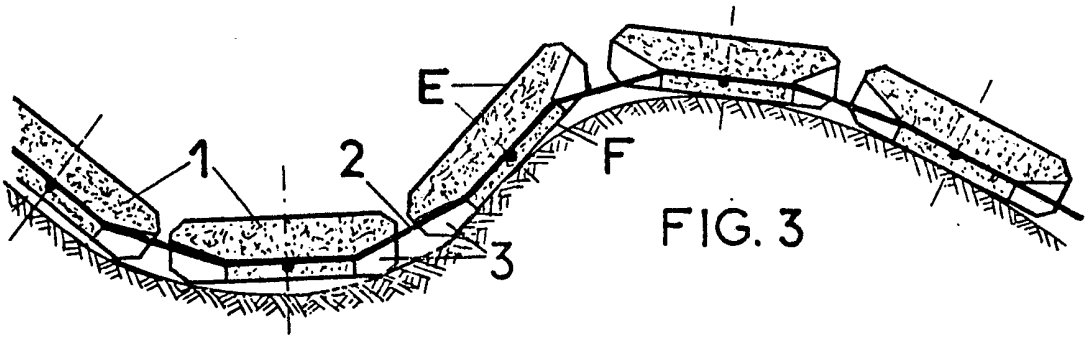

FIG. 3

2/2

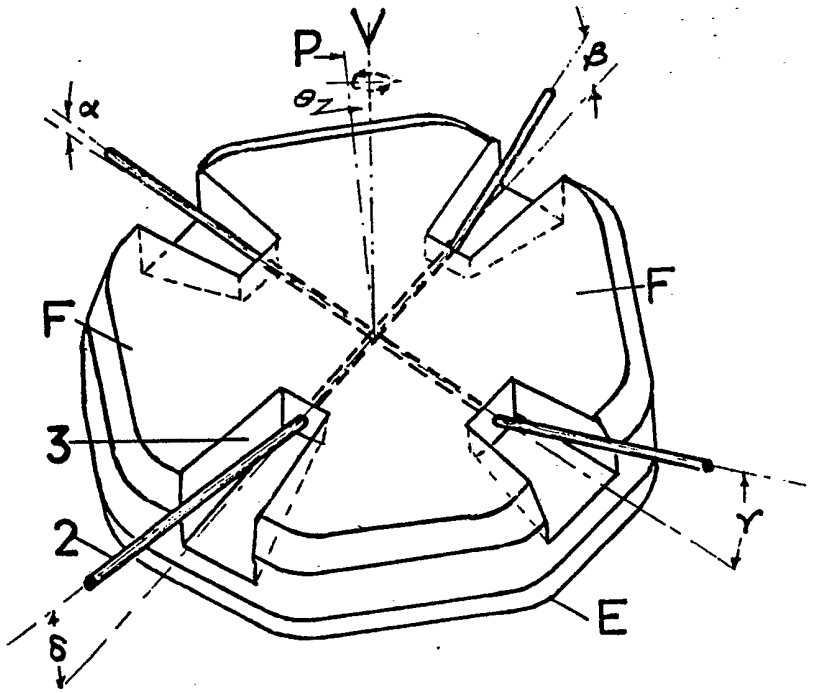

FIG.4

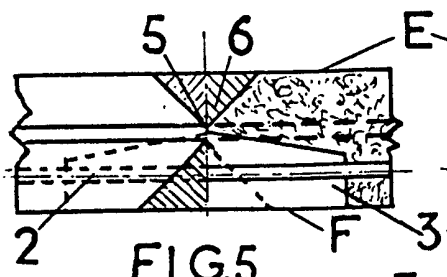

FIG.5

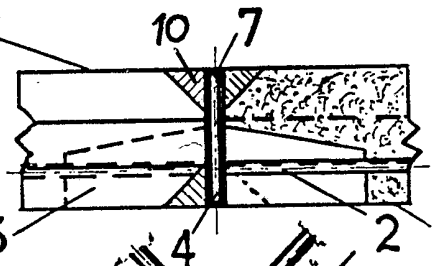

FIG.6

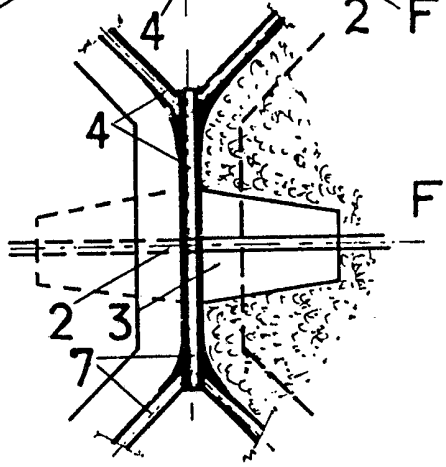

FIG.7

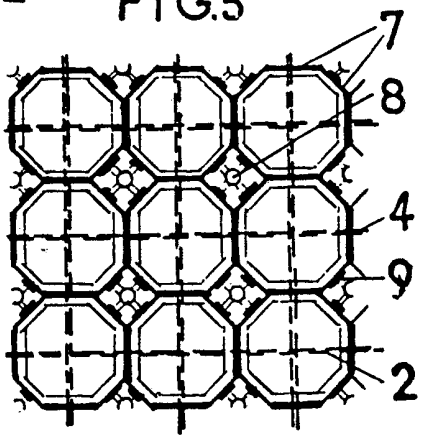

FIG.8

SPECIFICATION

Improvements in or relating to a method of and device for use in preventing ground erosion and maintaining earth stability

This invention relates to improvements in a method of, and the provision of a flexible continuous structure for, preventing ground erosion, and is particularly concerned with maintaining the stability of earth. Such flexible continuous structures are commonly referred to as ground revetments, and are used in many and varied applications; for example they can be used to surface the sides, or bottoms, of canals, or to prevent the wave erosion of coasts or dykes, or as supports for underwater structures.

Many systems of revetments, at present in use, require the preparation of separate blocks of a castable material, the said separate blocks being thereafter manually placed side-by-side upon an earth base, to form a discontinuous paving thereon. Alternatively the separate blocks may be preassembled into mats, or panels, by means of flexible tendons or the like, the said assembled blocks being thereafter laid as a flexible connected, or partly connected, structure over an earth base. Such systems are expensive in labour and are time-consuming in prefabrication. Moreover the revetments rely for their static stability either upon their weight alone, or by attachment to adjacent structures, or to simple shallow anchors or pickets having indeterminate holding powers.

It is an object of the present invention to provide an improved ground revetment which shall be economical to manufacture, simple to install, robust in use, and difficult to disturb when in its installed position.

It is a further object of the present invention to provide an improved ground revetment which shall be simultaneously flexible in two or more directions the degree of said flexibility being substantially the same for any plurality of variable directions.

According to one aspect of the present invention there is provided a method of producing a flexible ground revetment which comprises the steps of supporting a mesh, or lattice, of flexible tendons within a compound mould in which a panel, or plurality of blocks, may be simultaneously cast, the said mesh, or lattice, being so supported within the said compound mould that one or more tendons, forming the said mesh, or lattice, are secured within the mass of each cast block forming the said panel.

In order that a flexible continuous structural revetment panel shall be similarly flexible in a plurality of angularly variable directions, it is necessary that the flexible tendons connecting adjacent blocks of the said panel shall have free lengths sufficient to allow said blocks to freely adopt mutually inclined attitudes tangential to both convex and concave curved surfaces, the degree of flexibility being a geometric function of the said free tendon length, the dimensions and configuration of the said blocks, and the curvature of the said convex or concave curved surfaces.

Furthermore, in order that the said free lengths of connecting tendons be exposed to a minimum between adjacent blocks comprising the said panel, it is necessary that the said free lengths of tendons operate within chambers formed beneath the exposed surfaces of the said blocks, the dimensions of the said chambers being determined by the said geometrical flexibility function.

One configuration of the said mould is such that the adjacent sides of the blocks forming the said panel, when cast therein, are established by intersecting fracture planes, or planes of controlled weakness in the said panel, said planes being generally, but not necessarily, normal to the plane of the mesh, or lattice, and situate transversely to the said free length or lengths of tendon which are to join adjacent sides of the said blocks, each pair of said adjacent sides being mutually formed by the fractioning at the said plane of controlled weakness. Otherwise expressed, following the separation of the said cast panel from the mould the said cast panel may thereafter be converted to a flexible panel of discrete blocks, inter-connected by the cast-in flexible tendons of the encased mesh, said conversion being effected by a two-dimensional breaking at the fracture planes established in the original cast panel, as heretofore described.

Another configuration of the said mould is such that the sides of the castable blocks forming a panel of inter-connecting blocks are mutually separated by removable moulding shutters, or forms, configured to the required cast sides of the said blocks, the said removable moulding shutters or forms, being provided with locating blocks or clamps, or similar means to define the shape or shapes of the said blocks and also with slots, or similar means, whereby the said tendons connecting the said blocks may pass through the said shutters, and from which they may be separated after the casting of the said blocks has been completed.

In both aforesaid forms of moulds, to provide the configurations of said blocks forming a continuous flexible revetment panel, provision is made for the formation of chambers in which the free lengths of all said block-connecting flexible tendons may freely move, the said free lengths having a minimum exposure between adjacent blocks.

As will be appreciated, the cast blocks, forming panel mosaic, may be of any shape, or shapes, and may be connected together by any plurality of tendons, located relative

thereto. Furthermore, the said tendon mesh, or lattice, may be contained by any required plane, or planes, within the volume of the said panel blocks.

According to a preferred embodiment of the invention, there is provided a flexible revetment structure, comprising a panel of any size, formed from a castable material, such as, for example, concrete, and cast within a mould, said mould being provided with means whereby said panel may be divided into contiguous blocks of said castable material, said panel having a mesh, or lattice, of flexible tendons supported by said mould prior to casting of said panel, and thereafter cast integrally within the depth thereof, said mesh, or lattice, having lengths between adjacent blocks which are free to move in any direction relative to said blocks within chambers cast therein, each said chamber extending from a closed end within said block to communication with an associated side thereof, said chamber being generally bell mouthed and with cross-sectional dimensions increasing outwardly towards said opening in side of said block, said chamber being open on the bottom face of the said panel, that is to say on the face to be laid on the earth or ground surface, and extending part way only into the said depth of the said panel, the length and cross-sectional dimensions of said chambers being functions of the required degrees of flexibility of the flexible structure.

With advantage, the said blocks, comprising the said panel, will be so configured that their relative movement to conform to the said required degrees of flexibility of the structure, will be facilitated by a sufficient perforated area of panel surface to encourage the growth of vegetation.

It will also be apparent that when a continuous revetment structure is so large that a single panel would be impractical to cast, or transport, then the required continuous revetment structure may be constructed from flexible panels of connected blocks of a practical handling size as heretofore described, said panels being thereafter inter-connected by all free lengths of flexible tendons extending from all sides thereof.

With advantage, when the said encastré tendons emerge into their associated said chambers, means may be provided to protect said tendons from wear, or abrasion, by their angular movement against the ends of their encastré lengths.

Embodiments of the invention will now be described, by way of example, reference being made to the accompanying drawings in which:—

Figure 1 is a plan view of part of one form of flexible panel, or mosaic, of blocks according to the present invention, said blocks being inter-connected by one form of tendon mesh.

Figure 2 is a part elevational, part sectional view of Fig. 1.

Figure 3 is a sectional elevation of a plurality of blocks, according to the present invention, when laid upon an undulating ground surface.

Figure 4 is a pictorial view of the underside of the block shown in Figs. 1 and 2, that is to say, of the surface of said block in contact with the ground surface, after the block has been laid thereon.

Figure 5 is a section through one form of mould in which a panel, or mosaic, of blocks, according to the present invention, may be cast.

Figure 6 is a section through an alternative, and preferred form of mould in which a panel or mosaic of blocks, according to the present invention, may be cast.

Figure 7 is a part plan, part sectional view of the mould shown in Fig. 6, together with its associated cast blocks.

Figure 8 is a plan view of part of the mould of the panel of blocks shown in Figs. 6 and 7 in which, by way of example, are shown arrangements for mutually vibrating, or otherwise compacting or consolidating, castable material comprising the said blocks of the said panel.

The panel, or mosaic, of castable blocks illustrated in Figs. 1 and 2, comprise a pluraltiy of castable blocks 1, each having an upper surface E and lower surface F and sides A, A^1, B, B^1, C, C^1, and D and D^1 each of which may be formed with a zone of controlled weaknesss, that is to say with a zone in the said side, castably connected to an associated side of an adjacent block which may, after the completion of the panel, be broken to separate the said one side from its said associate adjacent side. Alternatively the said sides of each block may be formed by a compound panel mould as illustrated in Figs. 6 and 7 and described hereunder.

Within the volume of each said castable block chambers or recesses 3 are formed in alternate opposing sides C and C^1 and D and D^1, which said chambers or recesses 3 are open-ended at their associated sides and which preferably, although not necessarily, are also open at the lower surface F of the block, but do not extend to its upper surface E. Within said chambers 3 tendons 2 which are cast within the volume of the block 1, and connecting said block to adjacent blocks, may be angularly displaced in any direction, thereby allowing said connected adjacent blocks to mutually move, or relatively deform, in differing individual directions as shown by broken planometric lines in Fig. 1, and the undulating vertical section in Fig. 3.

Otherwise expressed, according to Figs. 1 and 2 and 3, the tendon chambers, or recesses, 3 with their associated cast-in tendons 2, allow a panel, or mosaic, of connected blocks 1, having configurations as shown

therein, to adopt relatively differing attitudes in a plurality of mutually random directions.

Fig.4 illustrates a block 1 whose axis P, normal to the faces E and F is inclined at a solid angle θ to the vertical "V", and whose tendons 2, after emerging from the volume of the said block 1 into their associated chambers 3, are thereafter inclined at angles α,β, γ and δ through their attachment to adjacent blocks inclined at differing values of θ.

In Fig. 5 the zone of controlled weakness 5 is formed to coincide with the plane of the encastré tendon mesh 3 by the mould fillets 6, extending from the said plane to the faces E and F of the block.

In Fig. 6 and 7 the blocks are positively separated by the mould sides 7, the chamfer fillets 10 being engaged therewith during the casting of the said panel of blocks, and removed thereafter, the sides 7 being provided with slots, or the like, through which the tendons 2 may pass and be subsequently separated therefrom.

Fig. 8 illustrates one method by which the sides of the compound mould shown at Figs. 6 and 7 may be vibrated, or otherwise treated, to improve, or promote, the casting process of the panel of blocks 1, the alternate opposing sides of each adjacent block being provided with contact means 9 for their vibrating or similar treatment by vibrator or similar appliance 8, operated in the spaces in the panel formed by the said alternate opposing sides of four adjacent blocks.

CLAIMS

1. A Flexible Revetment Panel comprising a plurality of blocks of a castable material interconnected by a two-dimensional mesh of cables cast within the volume of each said block the plane common to the said two-dimensional mesh of cables being substantially parallel to the base face of said panel.

2. A Flexible Revetment Panel according to Claim 1 in which each said block of castable material is provided with a plurality of chambers cast therein said chambers being open-ended at the faces of opposing sides of said block and extending partway into the volume thereof and within which said chambers an associated cable is free to deflect from the longitudinal axis of its length cast within said volume of said block.

3. A Flexible Revetment Panel according to Claim 1 and 2 in which said chambers are open to both a side and the base surface of said block.

4. A Flexible Revetment Panel according to Claim 1, 2 and 3 in which said Flexible Panel is cast in a compound mould provided with intersecting spacing members or mould battens which define and separate the side configuration of each said block comprising said panel and which support said two-dimensional cable mesh prior to the casting of said panel said spacing members or mould battens being removeable from said mould after the casting of said panel.

5. A Flexible Revetment Panel according to Claims 1, 2 and 3 in which said Flexible Panel is cast in a compound mould provided with removeable fillets to induce zones of controlled weakness within the said panel said zones of controlled weakness defining the side configuration of each of said plurality of blocks comprising said panel and so arranged as to allow the said cast panel to be thereafter fractured along said zones of controlled weakness to provide said Flexible Panel of interconnected blocks.

6. A Flexible Revetment Panel according to any of the preceeding Claims in which each of the said plurality of interconnected blocks comprising said panel are provided with shafts or holes connecting with their upper and lower surfaces and through which vegetation may grow or in which wave or current energy may be dissipated.

7. A Flexible Revetment Panel according to any of the preceeding Claims in which the sides of said plurality of interconnected blocks comprising the said panel are configured to provide open volumes there-between through which vegetation may grow or in which wave or current energy may be dissipated.

8. A Flexible Revetment Panel constructed arranged and adapted to operate substantially as herein described with reference to Figs. 1–8 of the accompanying drawings.

9. Any novel subject matter or combination including novel subject matter herein disclosed whether or not within the scope of or related to the same invention as any of the preceeding Claims.

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