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(54) Channel lining structure and installation method

(57) A channel lining structure for a gutter or diversion ditch includes a prefabricated element (1) forming the base of a channel, particularly of a channel adjacent to a roadbed, and an associated geomat (2), extending outward from at least one lateral portion of the prefabricated element (1). A method for the installation of this lining structure is also described.

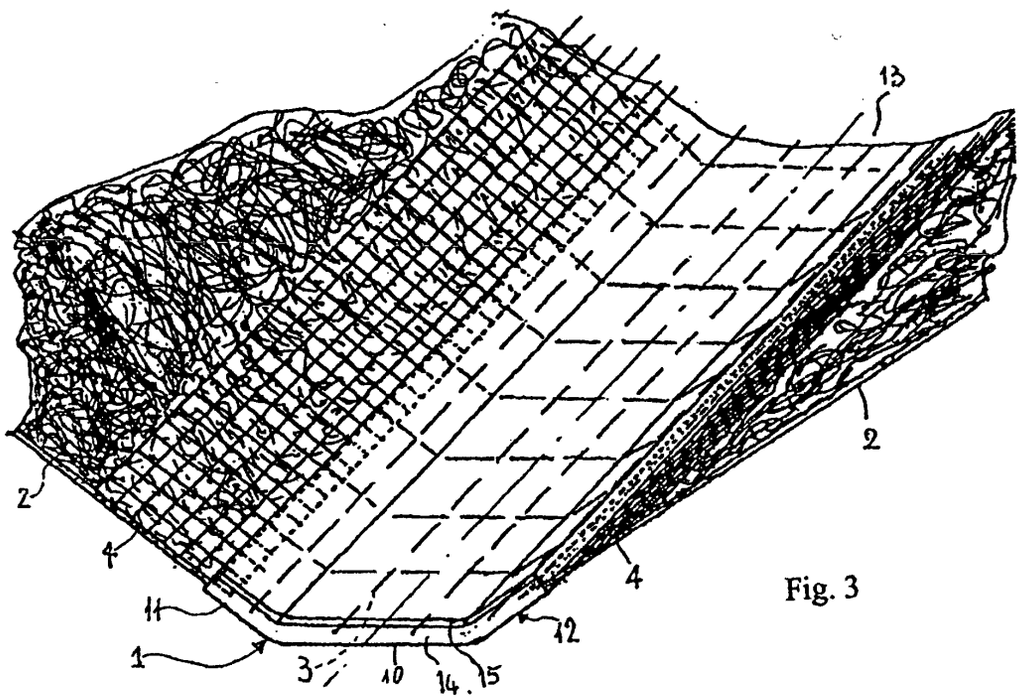

Fig. 3

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Description

[0001] The present invention relates to a channel lining structure for protecting road gutters or diversion ditches. The invention also relates to a method for the installation of this lining structure.

[0002] In the field of the construction of roadbeds or railbeds in general, the bed comprises the carriageway or ballast and, in the case of a sunken road, the "diversion ditch". This diversion ditch, as its name implies, is positioned to protect the roadbed and serves to collect the rainwater flowing from the top to the base of an embankment, as shown in Figure 1, or on the top of the slope for roads in cuttings, as shown in Figure 2, with particular reference, purely by way of example and without restrictive intent, to a railbed. In the figures, the diversion ditch is indicated by F, while the letter C identifies the channel. The slope, which has an appropriate inclination depending on the geotechnical characteristics of the soil and the position of the roadbed with respect to the natural surface level, is indicated by S.

[0003] Normally, the channel of a gutter or diversion ditch is covered with prefabricated elements of reinforced concrete.

[0004] At present, to avoid damaging the landscape by using a concrete cover or covering with other construction materials to protect slopes from wash-out and erosion, perforated elements of plastics or ceramic material are installed together with the prefabricated channel sections. The apertures in these elements allow the growth of vegetation which improves the appearance of the environment and provides satisfactory soil adhesion by means of the roots. However, this covering is very costly as regards the materials and their installation.

[0005] An object of the present invention is to provide a lining for channels while providing adequate protection of the slopes.

[0006] Another object of the invention is to provide a covering for channels and slopes in a simple and inexpensive way.

[0007] According to a first aspect of the invention, what is provided is a channel lining structure for a gutter or diversion ditch, which includes a prefabricated element forming the base of a channel, having lateral portions generally inclined upward so that they cover the lower portions of the walls of the channel, and an associated "geomat", in other words a mat for covering the soil with an irregularly interlaced loose mesh described more fully below, extending outward from at least one lateral portion of the prefabricated element.

[0008] According to a second aspect of the invention, what is provided is a method for installing a channel lining for a gutter or diversion ditch.

[0009] The present invention will now be described with reference to a preferred embodiment, provided by way of example and without restrictive intent, it being understood that variations may be made in respect of construction without departure from the scope of protection of the present invention, and with reference to the figures of the attached drawings, in which:

Figure 1 shows a schematic cross section through a bed, for example a railbed, forming an embankment, to which the structure according to the present invention can be applied;

Figure 2 shows a schematic cross section through a bed, for example a railbed, located in a cutting, to which the structure according to the present invention can be applied;

Figure 3 is a partial axonometric view of an embodiment of the structure according to the present invention;

Figure 4 is a cross section of the embodiment of Figure 3; and

Figure 5 is a partially sectional end view of an alternative embodiment of a prefabricated element.

[0010] With reference to Figures 3 and 4, what is shown is the general appearance of an embodiment of a channel lining structure according to the present invention. It can be adapted to the channel of a diversion ditch F of Figures 1 and 2, and to the channel of a gutter C of Figure 2, as described more fully below.

[0011] The channel lining structure includes a prefabricated element 1 and a geomat 2.

[0012] The prefabricated element 1 is designed to form the base of the recess of a channel, particularly of one adjacent to a bed for a highway, railroad or the like. According to the invention, the prefabricated element can consist of a reinforced concrete section having an electro-welded reinforcing mesh 3 (Figure 4), for example a 20 x 20 cm mesh consisting of 5 mm diameter wires, indicated by the long-dashed lines in Figure 3.

[0013] The prefabricated element 1 has a base plate 10 and lateral portions 11 and 12. The base plate 10 is shown as flat in Figures 3 and 4, but could also be slightly curved with an upward concavity or could have longitudinal grooves 10', as shown in Figure 5, while the lateral portions 11 and 12 are generally inclined upward to cover the lower portions of the walls of the channel in which the prefabricated element is installed.

[0014] In particular, in the case in which the base of the prefabricated element has longitudinal grooves 10', these eventually collect soil, allowing the spontaneous growth of vegetation on the bases of said grooves, which improves the appearance of the channel by the plant cover which is formed, thus decreasing the negative environmental impact of the bare concrete structure. In this embodiment, the prefabricated element is cleaned by mechanical means in such a way as not to remove the vegetation growing on the bases of the grooves.

[0015] Also according to the invention, the bases of the grooves can be filled with soil immediately after the installation of the prefabricated elements, and can then be seeded in a conventional way or hydroseeded.

[0016] According to the invention, handling elements are provided for the manipulation and installation of the prefabricated elements, the handling elements consisting of removable threaded ring studs fitted in threaded housings sunk into the material of the prefabricated elements.

[0017] In an alternative which is not shown, the handling elements consist of substantially semi-annular steel bar elements embedded in the material of the prefabricated elements.

[0018] According to the invention, the prefabricated element 1 has extension elements on at least one of its lateral portions. Advantageously, this extension element can be made during the manufacture of the prefabricated element 1, by embedding a metal mesh 4. By way of example and without restrictive intent, the metal mesh 4 has cells of 5 x 5 cm, made from steel wire preferably having a diameter of 2 mm. The mesh is made to project from the lateral portions 11 and 12 by a suitable amount, as explained below. The mesh 4 is represented in Figures 3 and 4 in solid lines, while the part embedded in the concrete is represented by dotted lines.

[0019] The geomat 2 can be, for example, a structure consisting of filaments of synthetic materials (high-density polyethylene, polyamide, polypropylene or other material), consisting of fibers entangled in a random way to form a highly deformable layer having a thickness of 10-20 mm.

[0020] The geomat can also consist of a set of fine mesh lattices which may be structured, joined together by "stitching".

[0021] Examples of geomats which are used are "MACMAT", made by the Maccaferri company, and "ENKAMAT 7020" and "ENKAMAT 7010", made by SEIC Geotecnica.

[0022] Both types of geomat are characterized by a very high void ratio of more than 90% on average. They do not absorb water, and their mass per unit area varies from 250 to 500 g/m^2. The tensile strength varies according to the material and the manufacturing procedures, but is generally less than 10 kN/m.

[0023] In place of the aforementioned geomats, it is possible to use other lattice materials made from synthetic resins, called geosynthetics, normally available on the market, which can fulfill an equivalent function.

[0024] As shown in Figures 3 and 4, the geomats 2 are designed to be connected to the metal meshes 4 projecting from the lateral portions 11 and 12 of the prefabricated elements 1 by connector means such as pegs 5 made from metal or other materials, as shown in the figure, in the shape of an inverted U, an inverted L or a T, which can be fixed into the ground.

[0025] Preferably, the prefabricated elements 1 have front and rear edges 13 and 14 shaped in such a way as to provide a connection by interlocking or adjacent positioning with complementary designs, thus allowing a connection between the various prefabricated elements which is continuous, simple, and prevents slippage of the various elements or their misalignment with each other. This configuration with complementary profiles to allow the interlocking of the elements can be, for example, of the step type, the ramp type, the male and female groove type, or can have any other type of suitable profile indicated in a general way by 15 in Figure 3. The term "rear" denotes the upstream edge with respect to the direction of flow of the water in the channel. Thus, during installation, the front edge of one prefabricated element is interlocked by means of its projecting seam, or is superimposed by means of its step, on the groove, or on the step, of the rear edge of the next prefabricated element.

[0026] As regards the method for installing the channel lining structure in existing or newly constructed channels, the surface to be lined is first leveled and modeled, with the removal of sags, small projections, rubble and branchwood, such as branches, leaves and other vegetable detritus. The leveled surface is then seeded and fertilized if necessary. A trench (not shown in the figures) with a width of at least 50 cm and a depth of 20-30 cm is formed above the slope. A flap measuring approximately 50 cm at the edge of the geomat is placed in the trench, is fixed with iron pegs and is covered with the soil taken from the excavation. The pegs preferably have a minimum diameter of 8 mm.

[0027] A geomat made from synthetic material (nylon, polypropylene, polyethylene, high-density polyethylene) is spread out along the line of maximum inclination of the slope. The adjacent geomat sheets are positioned in such a way as to overlap each other in the direction of the potential flow of water. The geomat is fixed to the soil with brackets in the form of an inverted U, an inverted L or a T, or with shrubs and/or cuttings, along the overlaps of the various sheets used and in the centers of the sheets. The density of the soil fixing pegs increases with an increase in the inclination of the slope and according to the consistency of the substrate. Generally, one peg per m^2 is sufficient for inclinations of less than 20-30°.

[0028] The prefabricated elements according to the invention are then installed in succession in the recess of the channel of the diversion ditch or gutter, with portions of metal mesh projecting from at least one of the lateral portions of the prefabricated elements, and the metal mesh is connected to the geomat by means of pegs. After this, together with this or as an alternative, shrubs and cuttings can be planted by making L-shaped cuts in the geomat, and the geomat can be filled with agricultural soil. It is also possible to seed the soil under the geomat with a suitable mixture of seeds of selected plant species, and fertilize and irrigate it.

[0029] Alternatively, the geomat can be filled with ballast and bituminized. The geomat can have a minimum

thickness of 8 mm if it is filled with soil and a minimum thickness of 18 mm if it is filled with ballast and bituminized. It is useful for the geomat to have a tensile strength of not less than 2.0 kN/m with a void ratio of not less than 90%.

[0030] The installation of the prefabricated element and the spreading of the geomat can be carried out at any time of the year. Seeding should preferably be carried out from autumn to spring, while the dry summer periods should be avoided; any planting of shrubby species should take place during the vegetative rest period but not in frosty periods in winter.

[0031] The mesh projecting from the shaped section according to the invention is preferably provided with a corrosion-proof coating, such as galvanizing treatment, or treatment with any other material capable of resisting oxidation at least for the whole of the period required for the growth of the vegetation.

[0032] The overlapping of the adjacent sheets of geomat, and their spreading and fixing must take into account the direction of the flow of water, in order to avoid undermining due to water infiltration.

[0033] The lining structure according to the invention is applied to all diversion ditches and all gutters of roads and highways, and also those of railroads, for rainwater collection, where these elements are subject to surface erosion and have no plant cover. The prefabricated element made from reinforced concrete serves to impart a regular shape to the channel, enabling the channel to be maintained with mechanical means.

[0034] Geomats are used to improve the resistance to erosion caused by the impact of rain and run-off water, to provide a surface reinforcement during the period of growth of the vegetation.

[0035] The advantages of the present invention are numerous. The surface on which the work is performed is immediately covered, both as regards the base of the channel and the slope part, thus providing immediate and lasting protection against surface erosion. During installation, the various prefabricated elements can be connected to each other easily by the interlocking of the groove and projection with complementary profiles or the overlapping step. The prefabricated element on the base of the channel allows rapid execution of maintenance and in particular allows the base to be cleaned by mechanical means, without adverse effects on the functionality of the installation or breakage of the geomat. The environmental impact is smaller than that of simple concrete channels, since after the growth of the vegetation the appearance will be identical to that of natural earth channels covered with vegetation, with the difference that when maintenance is carried out there is an advantage in terms of productivity due to the presence of the rigid base. In this way an appropriate compromise is achieved between efficient erosion prevention, technical functionality, maintenance requirements and low environmental impact.

[0036] Additionally, the void ratio of the mat is such that herbaceous plants can develop to supplement the mechanical erosion prevention provided by the mat. The soil material lying under the mat is retained, thus preventing its downward drift.

Claims

1. A channel lining structure for a gutter or diversion ditch, including a prefabricated element forming the base of a channel, particularly of a channel adjacent to a roadbed, railbed or the like, having lateral portions generally inclined upward to cover the lower portions of the walls of the channel, the prefabricated element having a front edge and a rear edge, **characterized in that** the prefabricated element is associated with a geomat extending upward from said prefabricated element, substantially in the form of an extension of at least one lateral portion of the element.

2. The structure as claimed in claim 1, **characterized in that** the prefabricated element is made from reinforced concrete and is provided with an extension element fixed to at least one lateral portion of the prefabricated element, to which the geomat can be fixed by connector means.

3. The structure as claimed in claim 1 or 2, **characterized in that** the base of the prefabricated element has a flat base, or a curved base with the concavity facing upward, or a base provided with longitudinal grooves.

4. The structure as claimed in any one or more of the preceding claims, **characterized in that** the base of the prefabricated element has longitudinal grooves, which, when filled with soil, allow the growth of vegetation on the bases of said grooves with the formation of plant cover which decreases the negative environmental impact.

5. The structure as claimed in any one or more of the preceding claims, **characterized in that** the prefabricated element has removable threaded ring studs fitted in threaded housings sunk into the material of the prefabricated element to allow the manipulation and installation of the element.

6. The structure as claimed in any one or more of the preceding claims, **characterized in that** the prefabricated element has substantially semi-annular steel bar elements embedded in the material of the prefabricated element for the manipulation and installation of the element.

7. The structure as claimed in any one or more of the preceding claims, **characterized in that** the geo-

mat is made from synthetic material included in the group comprising nylon, polypropylene, polyethylene and high-density polyethylene.

8. The structure as claimed in any one or more of the preceding claims, **characterized in that** the extension element is a mesh and the connection means are pegs for jointly fixing the mesh, as the extension element, and the geomat to the soil.

9. The structure as claimed in claim 8, **characterized in that** the pegs are in the shape of an inverted U, an inverted L or an inverted T, to interconnect the mesh and the geomat by their insertion into the soil.

10. The structure as claimed in claim 8, **characterized in that** the mesh is a metal mesh provided with corrosion-proofing coating, embedded in the prefabricated reinforced concrete element.

11. The structure as claimed in claim 10, **characterized in that** the corrosion-proofing coating consists of galvanizing treatment.

12. The structure as claimed in any one or more of the preceding claims, **characterized in that** the front and rear edges of the prefabricated element have ends with grooves and projections of complementary shape in such a way that the front edge of one prefabricated element is interlocked into the appropriate housing of the rear edge of a consecutive prefabricated element, with respect to the direction of flow of the water in the channel.

13. The structure as claimed in any one or more of the preceding claims, **characterized in that** the front and rear edges of the prefabricated element have alternating stepped ends in such a way that the front edge of one prefabricated element is overlapped onto the rear edge of a consecutive prefabricated element, with respect to the direction of flow of the water in the channel.

14. A method for installing the channel lining structure as claimed in any one or more of the preceding claims, comprising the following steps:

- leveling and modeling of the surface to be lined, and removal of sags, small projections, rubble and branchwood;
- formation of a trench uphill from the slope;
- positioning of a flap of the edge of the geomat inside the trench, fixing with pegs and covering with soil taken from the excavation;
- spreading a geomat along the line of maximum inclination of the slope and overlapping of adjacent sheets of geomat in the potential direction of flow of the water;
- fixing of the geomat to the soil;
- installation of prefabricated element, having portions of metal mesh provided with corrosion-proofing coating projecting from the lateral portions of the prefabricated elements; and
- connection of the metal mesh, provided with corrosion-proofing coating, to the geomat by means of pegs.

15. The method as claimed in claim 14, in which the prefabricated elements are manipulated and installed by gripping removable threaded ring studs fitted in threaded housings sunk into the material of the prefabricated elements.

16. The method as claimed in claim 14, in which the prefabricated elements are manipulated and installed by gripping substantially semi-annular steel bar elements embedded in the material of the prefabricated elements.

17. The method as claimed in any one or more of the preceding claims, additionally comprising filling longitudinal grooves provided on the bases of the prefabricated elements with soil and the subsequent seeding of this soil.

18. The method as claimed in any one or more of the preceding claims, additionally comprising the hydroseeding of longitudinal grooves provided in the bases of the prefabricated elements.

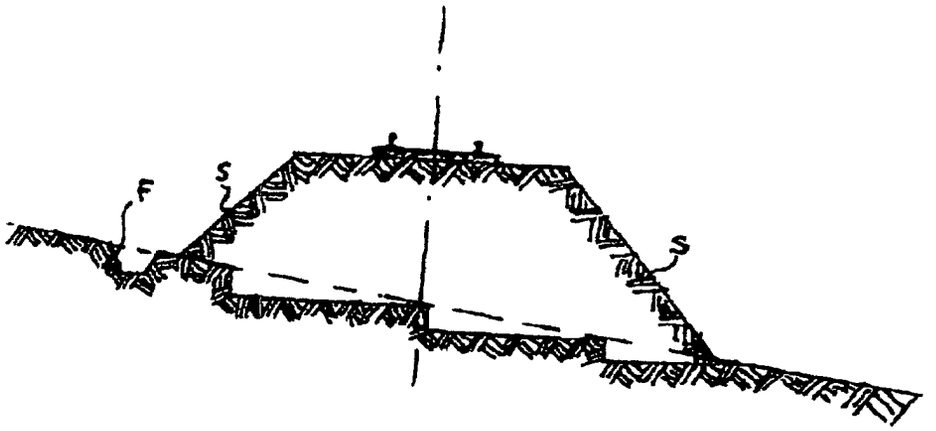
19. The method as claimed in any one or more of the preceding claims, additionally comprising the planting of shrubs and cuttings on the slopes by making L-shaped cuts in the geomat.

20. The method as claimed in any one or more of the preceding claims, additionally comprising the filling of the geomat with agricultural soil.

21. The method as claimed in any one or more of the preceding claims, additionally comprising the seeding of the soil under the geomat with a suitable mixture of seeds of selected plant species, and the fertilizing and irrigation of the soil.

22. The method as claimed in any one or more of the preceding claims, comprising the filling of the geomat with ballast and the bituminizing of the geomat filled in this way.

Fig. 1



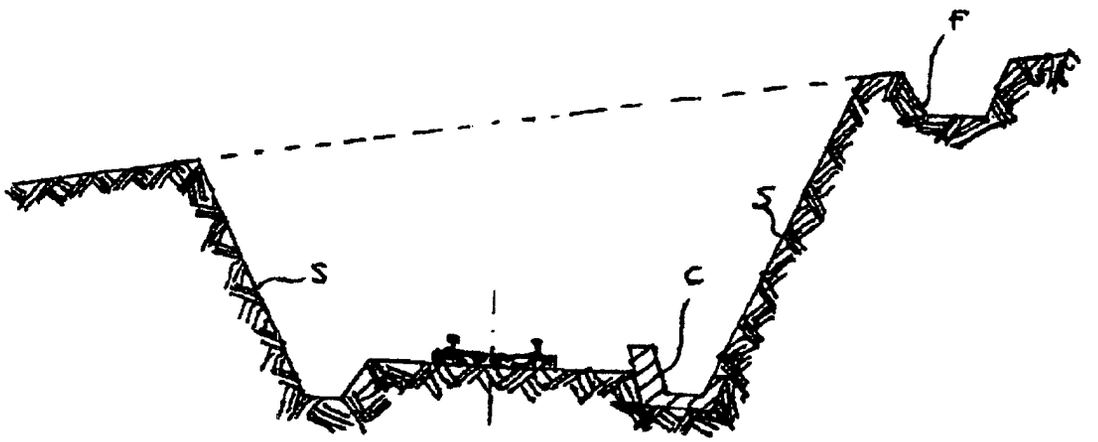


Fig. 2

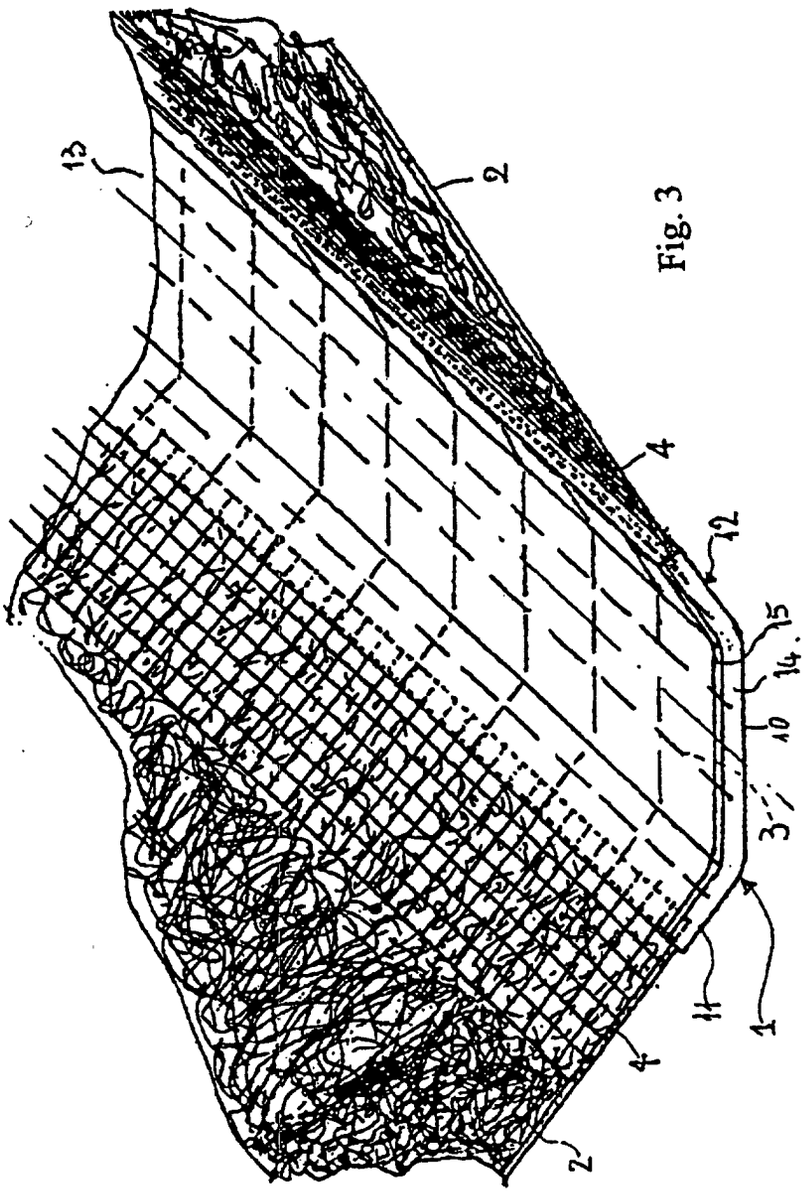


Fig. 3

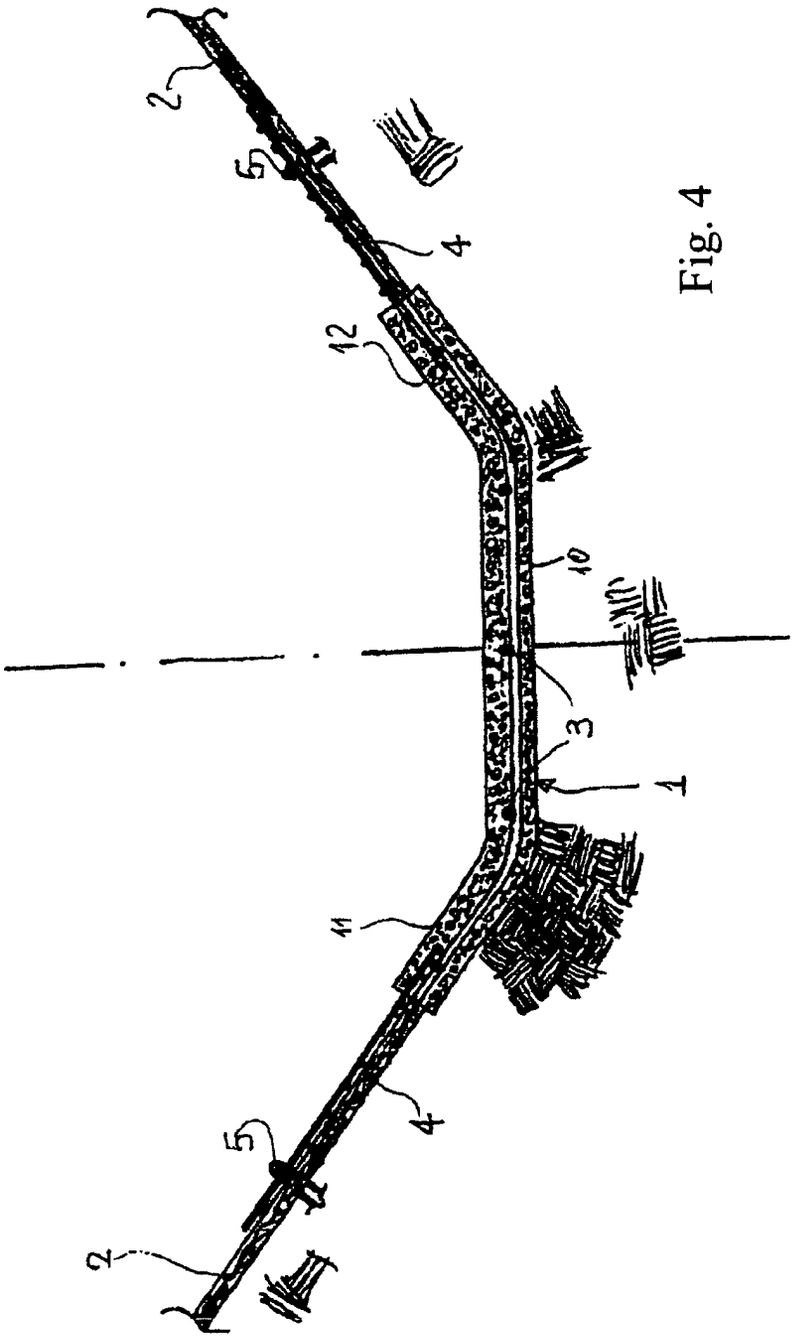


Fig. 4

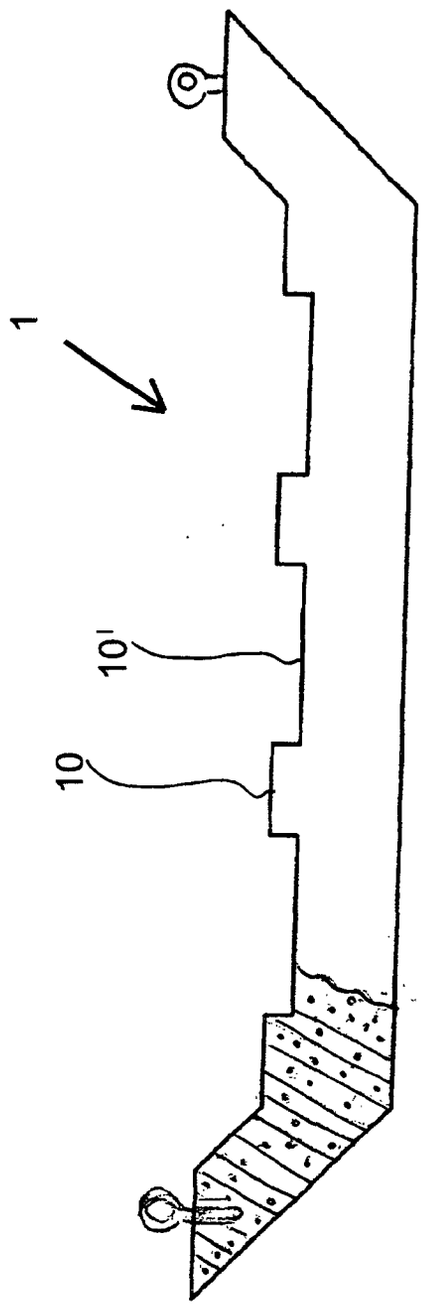


Fig. 5