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(54) Multi-axial textile grid for technical or geotechnical use and method to manufacture same

(57) Multi-axial textile grid (10) for technical or geotechnical use, comprising a mesh structure (11) formed by the orthogonal braiding of a plurality of weft elements (13) and a corresponding plurality of warp elements (12). The mesh structure (11) is made with the technology of warp knitting with DOS system weft insertion.

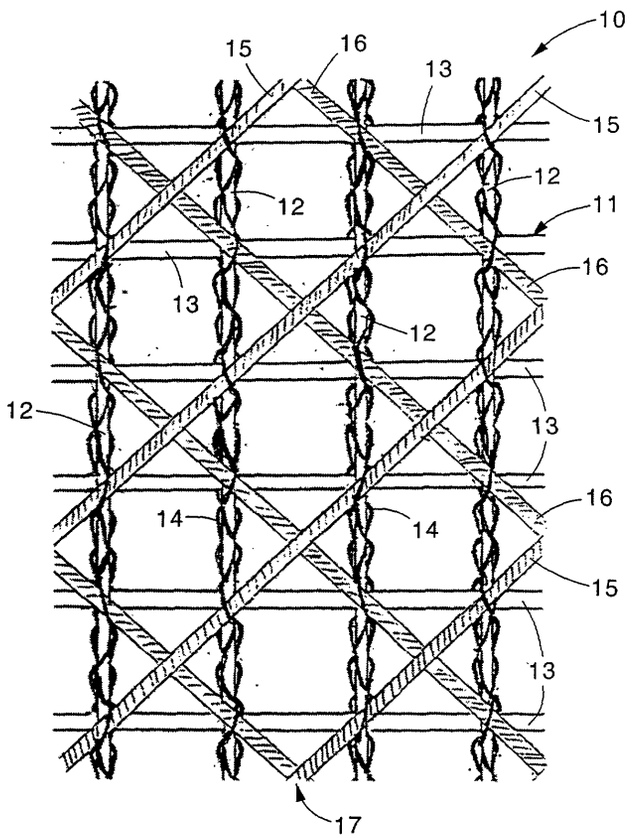

fig. 1

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Description

FIELD OF THE INVENTION

[0001] The invention concerns a multi-axial textile grid, for technical or geotechnical use, characterized by a mesh structure which allows it to resist both cutting forces acting on several axes in the same plane as the grid, and also torque forces acting thereon. Such grids, if used in the geotechnical field, are called "geogrids".

[0002] To be more exact, the textile grid according to the invention has a multi-axial structure reinforced and stabilized both along two axes orthogonal to each other and also along two further axes oblique and rotated with respect to the first two.

[0003] The invention also concerns the method to manufacture said multi-axial grids.

BACKGROUND OF THE INVENTION

[0004] The state of the art includes bi-axial textile grids used to impart stability and compactness to elements which are disconnected, incoherent and liable to slide or similar.

[0005] Such grids generally include a structure with orthogonal elements defined by a plurality of apertures which allow them to interact with the relative surfaces or supports on which they rest.

[0006] Conventional bi-axial textile grids, however, are not generally resistant either to cutting forces distributed over several axes or to torque forces on the plane, inasmuch as their mesh structures form a repetition of "articulated parallelograms" which resist the cutting forces only on two axes of geometry, that is, those along which the warp and weft elements are arranged, and yield to the torque forces which are in any case arranged on their plane.

[0007] Such bi-axial textile grids, in certain conditions of use, are therefore subject to limited efficiency.

[0008] It is known from US-A-5,795,835 a bonded composite knitted structural textile formed of knitted polymeric components. The first component is a high tenacity, high modulus, low elongation mono- or multifilament yarn. The second component is a fusible polymer in yarn which encapsulates and bonds adjacent load bearing yarns. The third component is an optional effect or bulking yarn. The fourth component is a multifilament warp knit stitch forming yarn to form the ground structure of the knitted textile. This structural textile has the disadvantage not to provide sufficient free area between the different links and not to have great features of resistance to the cutting forces in several directions and to the torque forces insisting on the same plane.

[0009] The present Applicant has devised and embodied this invention to overcome the shortcomings of the state of the art and to obtain further advantages.

SUMMARY OF THE INVENTION

[0010] The invention is set forth and characterized in the respective main claims, while the dependent claims describe other innovative characteristics of the invention.

[0011] The purpose of the invention is to achieve a textile grid characterized by great planar stability on a plurality of axes, and therefore suitable to guarantee great efficiency of use even in conditions of stress and high cutting forces and considerable torque forces.

[0012] To be more exact, the purpose of the invention is to achieve a multi-axial textile grid or geogrid suitable to considerably increase, with respect to the conventional multi-axial textile, the anchorage of the surface on which it rests, or of the elements incorporated therein and also to increase the friction coefficient or cohesion, in order to obtain extremely good results of dimensional stability, also with respect to conventional bi-axial grids.

[0013] The multi-axial textile grid according to the invention can be employed in every type of intervention where planning resistance and flexibility are required in the case of composite materials, both active and passive processes of protection and consolidation in the geotechnical field or in other technical solutions concerned.

[0014] This grid is therefore applied in achieving interventions of flexibility or resistance, reinforcement or stabilization in the field of industry, roads, railways, or airports and similar, reclamation and protection against the erosion of banks of rivers, streams, canals, water courses and similar, reinforcement and protection against sea and wind erosion.

[0015] The invention provides to make this multi-axial textile grid by means of using the technology "warp knitting with weft insertion".

[0016] To be more exact, the multi-axial textile grid according to the invention is achieved by means of sequences of "three-hinge arches", and therefore absolutely stable, arranged in such a manner as to allow to obtain and therefore exploit an ample area, open and free, which allows to apply the grid thus obtained for the specific functions, of a technical and geotechnical type, which it has to perform.

[0017] The multi-axial textile grid for technical or geotechnical use according to the present invention comprises a first mesh structure formed by the orthogonal braiding of a plurality of weft elements and a corresponding plurality of warp elements, and a second structure formed by further bundles of yarn disposed obliquely with respect to such weft elements and to such warp elements. Such further bundles of yarn are orthogonal to each other and form a second mesh which defines groups of three-hinge arches located checker-wise inside the apertures of such first mesh structure formed by such weft and warp elements, leaving free areas.

[0018] The bundles of yarn are preferably disposed obliquely from 30° to 60° with respect to such weft and

warp elements, so as to be aligned with determinate points of crossing of such weft and warp elements. Moreover, such weft and warp elements and such bundles of yarn are attached to each other by another yarn shaped so as to form a joining chain, which defines a textile structure formed by three-hinge arches which confer on such mesh structure great features of resistance to the cutting forces in several directions and to the torque forces insisting on the same plane, and which define strongly linked junctions.

[0019] The open and free area between the strands, strips or suchlike can vary, within the field of the invention, between a minimum value of ten percent and a maximum value of ninety-nine percent, with relation to the hollow-full ratio.

[0020] The optimum value is selected in each case according to a better and more targeted interaction to be obtained between the multi-axial textile structure and the technical and geotechnical manufactured products, composite structures, thin layers, grounds with differing granulometry, vegetal soils, sands, limes, gravel, stones, cement or asphalt conglomerates, or otherwise.

[0021] According to the invention, the multi-axial textile grid is made with apertures with a minimum dimension of about 10x10 mm of free area, with a thickness varying from a minimum of about 0.2 mm to a maximum of about 10 mm, and with a resistance varying from about 10 kN/m to about 10,000 kN/m and more, with the materials and yarns available today.

[0022] In making said multi-axial textile grids, the invention provides to use, as a basic material, the following types of yarns:

- synthetic yarns of different polymeric derivation and/or their combinations;
- composite yarns characterized by a heat sensitive or heat opponent cuticle;
- technological yarns of mineral derivation;
- natural yarns of biological derivation.

[0023] The choice of using the various types of yarns, synthetic and non-synthetic, satisfies the capacity which they have of meeting the specific planning requirements, since the physical/chemical characteristics of the various materials mentioned, and their interactions with the environment for which they are mainly intended, are known.

[0024] The production process of said multi-axial textile grids advantageously provides finishing and enhancing steps, such as for example the impregnation of the fibres mentioned above with resins, whether they be polyolefin in origin, such as ethylene vinyl acetate, polyurethane, polystyrene, polyvinyl, such as polyvinyl chloride, or other types, heat treatments or otherwise. These finishing and enhancing steps allow to obtain a specific arrangement of the multi-axial textile grid according to the different purposes of use.

[0025] In all cases, the result is to obtain, thanks to the specific nature of the invention, a greater suitability both of use and of durability in the specific fields and sectors indicated above.

[0026] Therefore, the multi-axial textile grid according to the invention combines, in a non-obvious fashion, the advantages of conventional bi-axial textile grids, such as the quality of cohesion, with the advantages of multi-axial textile, such as the resistance to cutting and torque forces, at the same time eliminating the shortcomings of both, such as weakness for bi-axial textile grids and low cohesion for multi-axial textiles.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] These and other characteristics of the invention will be apparent from the description of a preferential form of embodiment of the invention, given as a non-restrictive example with reference to the attached drawings wherein:

Fig. 1 shows a schematic plane view of a multi-axial textile grid according to the invention;

Fig. 2 shows a schematic side view of the grid in Fig. 1 showing the multi-axial DOS textile.

DETAILED DESCRIPTION OF PREFERENTIAL EMBODIMENT

[0028] With reference to Figs. 1 and 2, a multi-axial textile grid 10 according to the invention comprises a mesh structure 11 formed by the orthogonal braiding of a plurality of weft yarns 13 and a corresponding plurality of warp 12. We hereby specify that in this description the term yarns is intended to mean both yarns as such, and also strands, straps and any other element suitable to be woven.

[0029] The yarns with which the weft 13 and warp 12 is formed are chosen from among various solutions of synthetic yarns of differing polymeric derivation, such as for example polyester, polyethylene terephthalate (PET), polyamide (PA), polypropylene (PP), polyethylene (PE), liquid crystal polymers (LCP), polyvinyl alcohol (PVA), oxidized polyacrylonitril (PAN), carbon fibre, polyethylene naphthalene (PEN) or similar, technological fibres of mineral derivation (glass fibre, ceramic yarns, metal yarns) or yarns of biological derivation (cotton, hemp, animal fleeces) or their combinations. Advantageously synthetic yarns and yarns of mineral derivation are mainly used.

[0030] The weft 13 and warp 12 yarns are grouped together in bundles, separated from each other so as to form a net with apertures which can vary according to the field of use of the grid 10 and are indicatively greater than or equal to 10 x 10 mm.

[0031] The grid 10 further comprises further bundles of yarns 15 and 16 disposed obliquely, advantageously between 30° and 60°, and in the case shown here at 45°, with respect to the bundles of weft 13 and warp 12,

in particular arranged so as to be aligned with determinate crossing points of the bundles of weft 13 and warp 12. The method used to achieve this crossing is the one known as "warp knitting with multi-axial DOS system weft insertion".

[0032] The bundles of weft 13 and warp 12 yarns, and the diagonal yarns 15 and 16, are able to be attached to each other by a yarn 14 shaped so as to form a joining chain, intended to obtain a textile structure formed by three-hinge arches, which confers on the mesh structure 11 characteristics of great resistance to the cutting forces in several directions and to the torque forces acting on the same plane.

[0033] In fact, the bundles of yarn 15 and 16 in the case shown here are orthogonal to each other and form a second mesh 17 which defines groups of three-hinge arches located checker-wise inside the apertures of the mesh formed by the bundles of weft 13 and warp 12, leaving the adjacent areas free.

[0034] The design of the mesh thus obtained increases the free area wherein the apertures of the contact surfaces are incorporated, and consequently the cohesion of the grid 10 with the supporting surfaces or with the elements incorporated therein, at the same time conferring a greater resistance and stability to the system.

[0035] The grid 10 can also be subjected to subsequent finishing and/or enhancing steps, as shown above.

[0036] It is clear, however, that modifications and/or additions can be made to the multi-axial textile grid 10 as described heretofore, without departing from the spirit and scope of the invention.

[0037] It is also clear that, although the invention has been described with reference to a specific example, a person of skill in the art shall certainly be able to achieve many other equivalent forms, all of which shall come within the field of this invention.

Claims

1. Multi-axial textile grid for technical or geotechnical use, comprising a first mesh structure (11) formed by the orthogonal braiding of a plurality of weft elements (13) and a corresponding plurality of warp elements (12), and a second structure formed by further bundles of yarn (15, 16) disposed obliquely with respect to said weft elements (13) and to said warp elements (12), **characterized in that** said further bundles of yarn (15, 16) are orthogonal to each other and form a second mesh (17) which defines groups of three-hinge arches located checker-wise inside the apertures of said first mesh structure (11) formed by said weft (13) and warp elements (12), leaving free areas.

2. Grid as in claim 1, **characterized in that** said three-hinge arches define, between said weft and warp elements (13, 12), an open and free area which can vary between a minimum value of ten percent and a maximum value of ninety-nine percent, with relation to the hollow-full ratio.

3. Grid as in claim 1, **characterized in that** said mesh (11) has a minimum dimension of about 10 x 10 mm of free area.

4. Grid as in claim 1, **characterized in that** said plurality of weft and warp elements (13, 12) has a thickness of between about 0.2 - 10 mm and a resistance from about 10 to about 10,000 kN/m and more.

5. Grid as in claim 4, **characterized in that** said elements (12, 13) comprise at least one of the following types of yarn: synthetic yarns of differing polymeric derivation and/or their combinations; composite yarns having heat sensitive or heat opponent cuticle; natural yarns of mineral derivation; natural yarns of biological derivation.

6. Grid as in claim 1, **characterized in that** said further bundles of yarn (15, 16) are disposed obliquely from 30° to 60° with respect to said weft (13) and warp elements (12), so as to be aligned with determinate points of crossing of said weft (13) and warp elements (12).

7. Grid as in claim 6, **characterized in that** said weft (13) and warp elements (12) and said bundles of yarn (15, 16) are attached to each other by another yarn (14) shaped so as to form a joining chain, which defines a textile structure formed by three-hinge arches which confers on said mesh structure (11) great features of resistance to the cutting forces in several directions and to the torque forces insisting on the same plane, and which define strongly linked junctions.

8. Grid as in claim 7, **characterized in that** said other yarn (14) is shaped like a joining chain and can run without distinction along the direction of the weft (13) and warp elements (12) or in the directions of said bundles of yarn (15, 16).

9. Method to make a multi-axial textile grid for technical and geotechnical use, comprising a first step to make a first mesh structure (11) formed by the orthogonal braiding of a plurality of weft elements (13) and a corresponding plurality of warp elements (12), and a second step to make a second structure formed by further bundles of yarn (15, 16) disposed obliquely with respect to said weft elements (13) and to said warp elements (12), **characterized in that** said second step provides that said further bundles of yarn (15, 16) are arranged orthogonal to

each other and form a second mesh (17) which defines groups of three-hinge arches located checkerwise inside the apertures of said first mesh structure (11) formed by said weft (13) and warp (12) elements, leaving free areas.

10. Method as in claim 9, **characterized in that** the methodology used to make the braiding of said weft elements (13) and warp elements (12) and said further bundles of yarn (15, 16) is that known as warp knitting with multi-axial DOS system weft insertion.

11. Method as in claim 9 or 10, **characterized in that** the angle formed between said weft (13) and warp elements (12) and said further bundles of yarn (15, 16) is between 30° to 60°, so that said further bundles of yarn (15, 16) are aligned with determinate points of crossing of said weft (13) and warp elements (12).

12. Method as in any claim from 9 to 11 inclusive, **characterized in that** said weft (13) and warp elements (12) and said bundles of yarn (15, 16) are attached to each other by another yarn (14) shaped so as to form a joining chain, which defines strongly linked junctions.

13. Method as in claim 12, **characterized in that** said other yarn (14) is shaped so as to form a joining chain and can run without distinction along the direction of the weft (13) and warp elements (12) or in the directions of said bundles of yarn (15, 16).

14. Method as in any claim from 9 to 13 inclusive, **characterized in that** it comprises finishing and enhancing steps, such as for example the impregnation of said elements or yarns with resins or by means of heat treatments.

15. Method as in claim 14, **characterized in that** said resins can be indifferently polyolefines, polyurethanes, polystyrenes, or polyvinyls.

16. Use of a multi-axial textile grid as in any claim from 1 to 8 inclusive, for a geotechnical field.

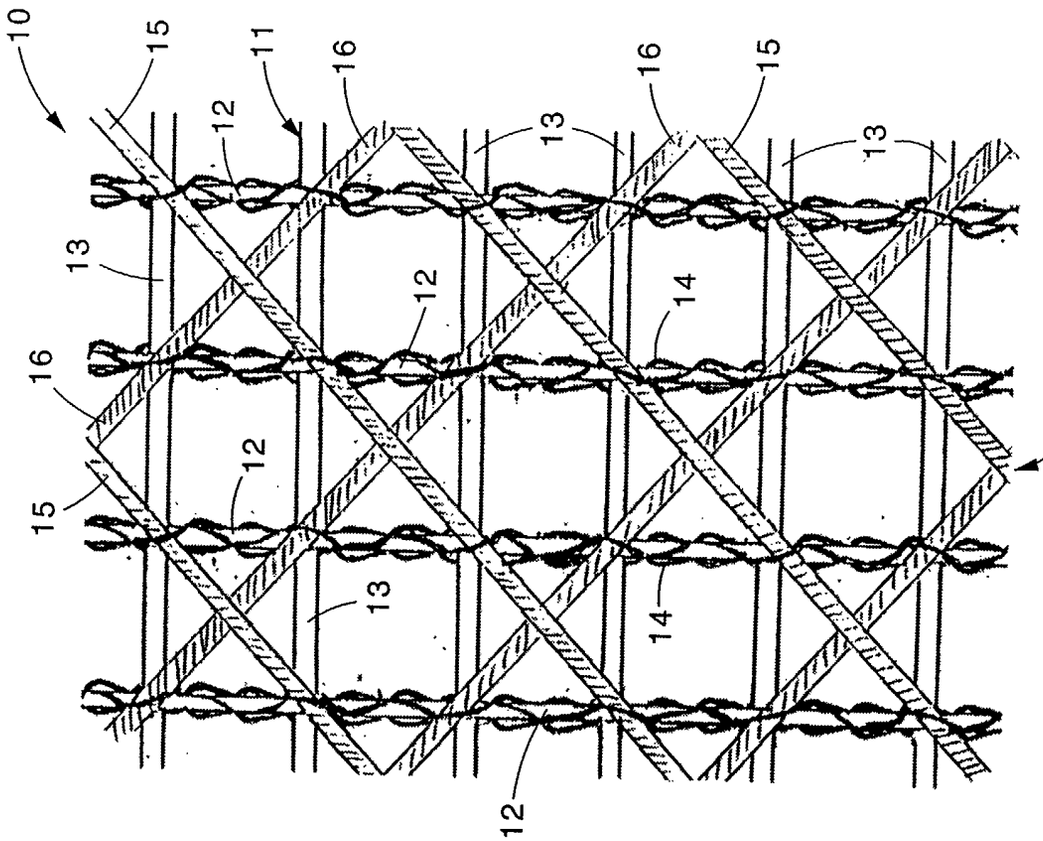
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fig. 1

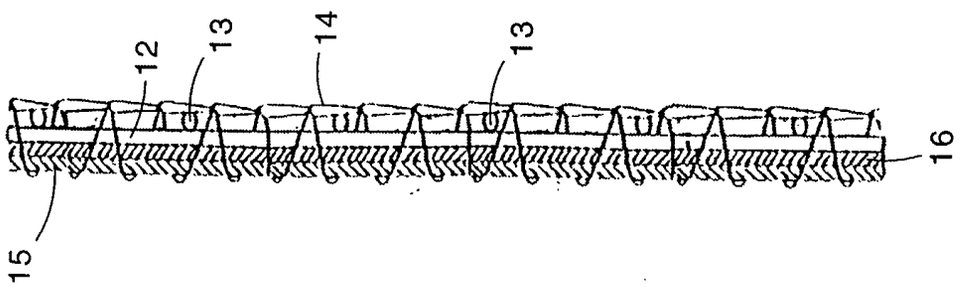
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fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 02 00 7003

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A	US 5 795 835 A (STEVENSON PETER E ET AL) 18 August 1998 (1998-08-18) * column 10, line 14 - column 14, line 65; figures 1-13,22-24 *	1,5-7, 9-12,14, 15	D04B21/14
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			D04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	15 July 2002	Van Gelder, P

CATEGORY OF CITED DOCUMENTS

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