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(54) **NET FOR SECURING ROCKS AND ROCK SLOPES**

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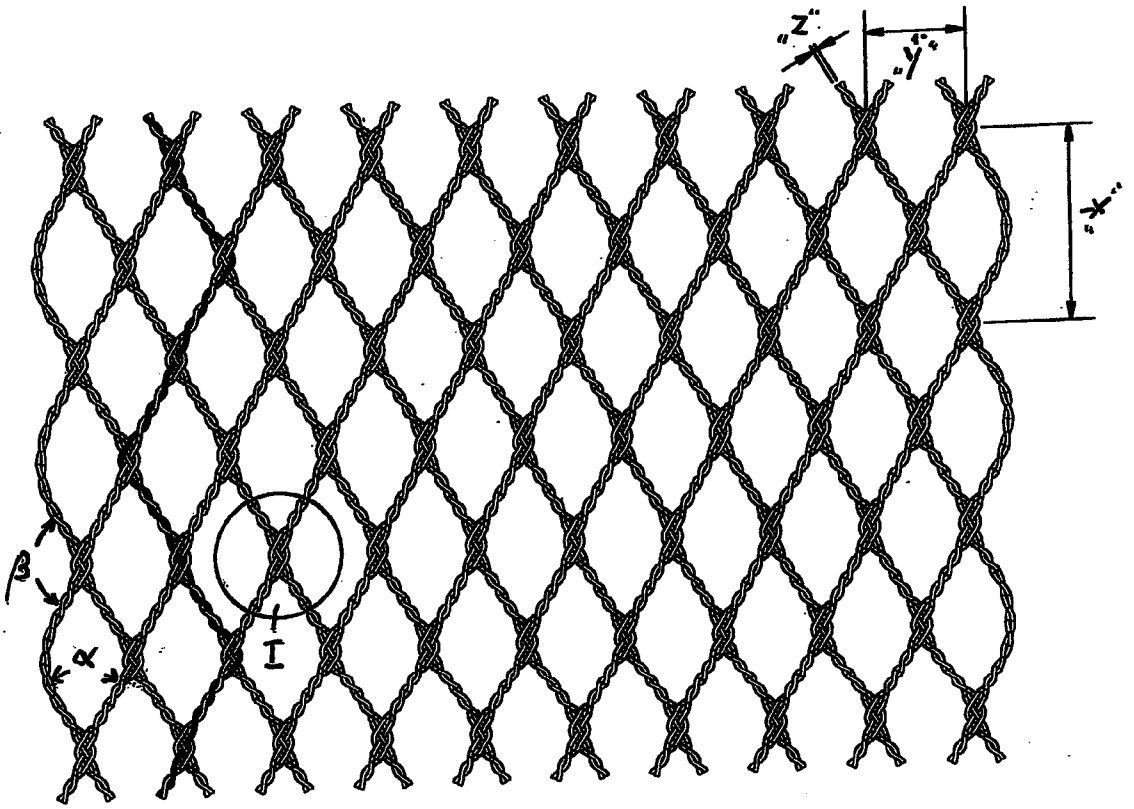
(57) **ABSTRACT**

Net as a securing or safety net for securing rocks or rock slopes, and against rock falls, landslides or similar natural hazards, wherein said net contains filament yarns from the group of multi- and/or monofilament yarns that are combined in a knot-free manner. In this net, in each case two material strands join at the mesh intersection points, wherein (a) each material strand (A; B) consists of at least two, preferably up to six, individual strands (A**1**, A**2** and B**1**, B**2**), and (b) at least one individual strand (A**1** B**1**) of each material strand (A or B) passes through an intersection point without changing direction, (c) while at least one individual strand (A**2** or B**2**) of each material strand (A or B) is deflected in the region of this intersection point and is combined with an individual strand (B**1** or A**1**) of the other material strand (B or A) that passes through an intersection point without changing direction.



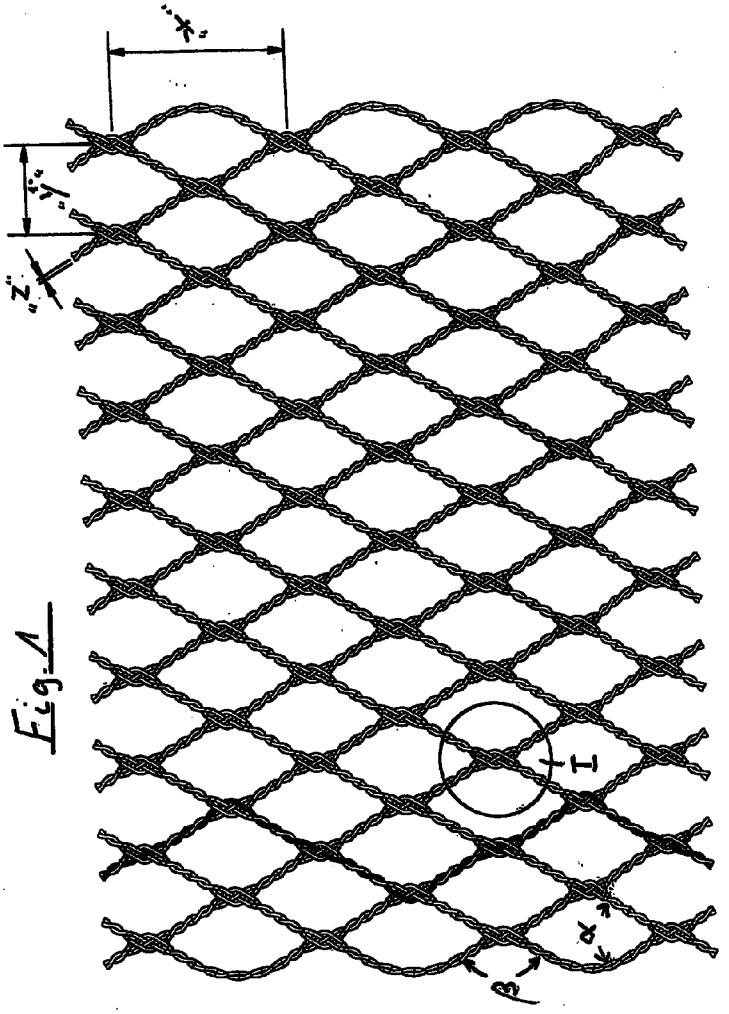


Fig. 1

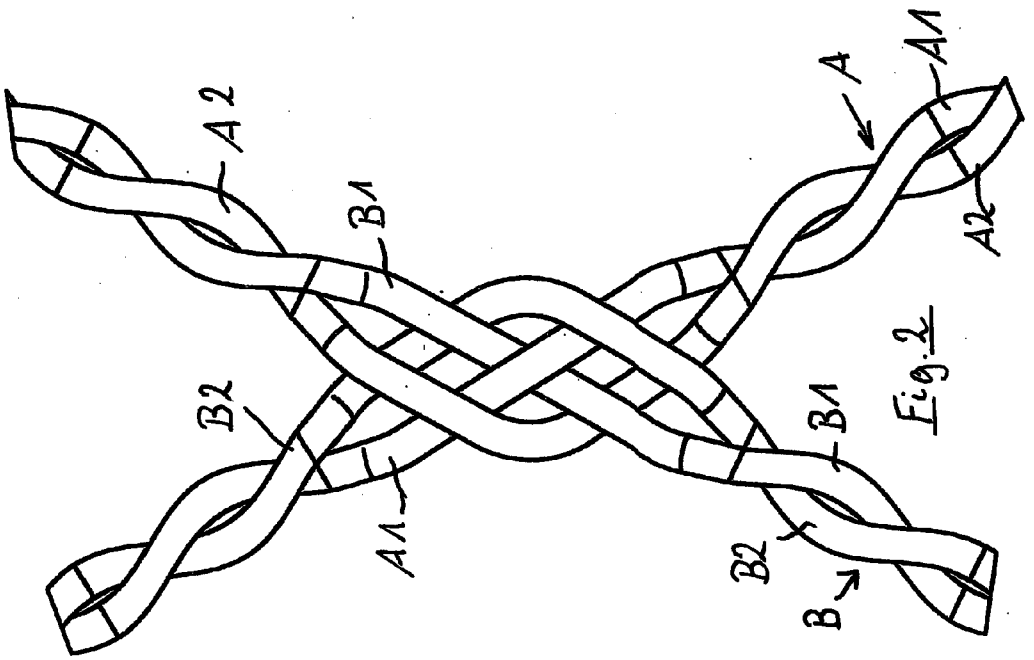


Fig. 2

NET FOR SECURING ROCKS AND ROCK SLOPES

[0001] The invention relates to a net as a catching net for securing rocks and rock slopes, falling rock, mudflow or similar natural hazards.

[0002] In case of nets as securing or safety nets for securing rock slopes and rocks as well as a protection against falling rock and similar natural hazards, the material properties of the used materials, aside from the net structure, are especially of essential importance with regard to the obtainable bearing capacity as well as with regard to the resistance to fracture and breaking of the material ropes.

[0003] EP 0 979 239 B2 describes a wire mesh for a falling rock guard or for securing an earth surface layer. The wire mesh preferably consists of high-strength steel wires, which are stranded to steel cords. The wire mesh is formed of a tetragonal diagonal mesh structure, the single meshes each constituting a rhomboid. The individual steel cords essentially extend in a zigzag-shape at a preferred angle of inclination of approximately 30°, which causes—due to the fact that the individual wires are wound around each other at the mesh crossing points—a deflection of the individual wires in the range of 120°; this is detrimental in particular in regard to the resistance to fracture and breaking.

[0004] In a wire mesh according to DE 23 27 005 B2, having also essentially rhomboidal meshes, two wires each meet at the mesh crossing points at an angle of inclination of approximately 30°, wherein one of these wires is pulled at an angle of deflection in a range of approximately 120° through a loop formed by the second wire which has a very detrimental bending angle in the region between 240° to 270°. The tetragonal wire mesh may be made of any plastically deformable material, especially bright or coated steel or aluminium wire.

[0005] It is an object of the invention to provide a net, haying improved properties compared with the known nets used for these purposes, as a securing or catching net for securing rocks and rock slopes as well as falling rock, mudflow and similar natural hazards.

[0006] For solving this object it is provided that the net contains filament-yarns of the group of non-metallic multi- and/or mono-filament yarns which are combined together free of knots.

[0007] The preferably exclusive use of non-metallic mono- and/or multifilament yams results in a considerable weight reduction and improved draping possibilities compared to steel wire nets or biaxial (polymer) fiber nets.

[0008] Preferred embodiments of the invention are described in the dependent claims **2** to **8**, which disclose materials which preferably are used for the net according to the invention. According to one preferred embodiment it is provided that the net preferably contains polymeric fibers, especially polyethylene fibers UHMWPE (=ultra high molecular weight polyethylene) as multifilament-yams. This is an ultrahigh molecular, partially crystalline thermoplastic material with an average molecular weight up to 5,000,000 g/mol and a density of 0.93 to 0.94 g/cm^3. This material is suited especially for nets for securing rocks and rock slopes due to its excellent resistance to wear and abrasion, a high impact resistance and notch impact resistance (even at temperatures up to **150**° C.), a low absorption of humidity, and a high resistance against chemicals. It is furthermore anti-adhesive and prevents caking.

[0009] Preferably, fibers having a filament tensile strength of 3,000 to 4,000 N/mm^2 are used. The net preferably has a net tensile strength of >150 kN/m.

[0010] The net preferably contains twisted yarns having titers of 1,200 to 1,800 dtex, especially 1,450 to 1,550 dtex, particularly 1,500 dtex.

[0011] An appropriate coating is provided for abrasion-protective and UV-protective purposes.

[0012] The net according to the present invention is advantageously characterized in that it is used as a safety net for securing slopes, rock slopes, and hazardous falling rock zones.

[0013] The net preferably contains protective elements for the fiber-protective fastening by means of clamping elements and/or rod anchors to the rock and slop areas to be secured.

[0014] In order to obtain a knot-free structure of the net in which two material ropes each meet at mesh crossing points, it is provided according to a preferred embodiment of the invention that

[0015] a) each material rope is composed of at least two individual ropes,

[0016] b) at least one individual rope of each material rope passes through the respective crossing point without directional change, while

[0017] c) at least one individual rope of each material rope is deflected in the area of the respective crossing point and is brought together with the individual rope of the other material rope passing through the crossing point without directional change.

[0018] In a net in which the material ropes meet each other in the area of oppositely situated crossing points at an angle α of, for example 60°, on the one hand, and at an angle β of, for example 120°, on the other hand, at least one individual rope passes through this crossing point as a continuous rope without deflection, i.e., at a material-protective bending angle tending toward 0°, whereas at least one further individual rope is deflected at an angle of approximately 30°. In this way, the load bearing capacity of the net is increased, on the one hand, and an enhanced resistance to fracture and breaking of the material ropes is achieved also, on the other hand.

[0019] The net according to the present invention is characterized in that it has a high elasticity and a high dimensional stability, while due to the continuous material ropes a high load bearing capacity is ensured.

[0020] According to a further preferred embodiment of the invention, an individual rope which passes through a crossing point without directional change is deflected in the area of the following crossing points and meets an individual rope which has been deflected at the preceding crossing point so as to change its direction.

[0021] According to a further preferred embodiment of the invention, it is provided that in the area of each following crossing point the individual rope which has passed a first crossing point without directional change is deflected and meets the individual rope which has been deflected in the first crossing point so as to change its direction.

[0022] Each individual rope is comprised preferably of a plurality of individual filaments or individual threads, which preferably are stranded, braided, twisted or are laid largely parallel to each other.

[0023] Each material rope preferably is comprised of at least two individual ropes, which preferably are stranded, braided, twisted or are laid largely parallel to each other.

[0024] The individual ropes and thus the material ropes preferably contain in particular filaments made of textile material, synthetic and/or natural as well as mineral fibers.

[0025] The preferred mesh structure of the invention will be described in the following with the aid of the drawing:

[0026] FIG. **1** shows a plan view of the net according to the invention;

[0027] FIG. **2** shows an enlarged view of the detail identified by reference character I in FIG. **1** in the area of a mesh crossing point.

[0028] FIG. **2** shows two material ropes A and B which contain, as starting material, at least two individual ropes A**1**, A**2** or B**1**, B**2** that are stranded or twisted with each other.

[0029] The two individual ropes A**1** and B**1** pass through the crossing point I without directional change. The two individual ropes A**2** and B**2** are deflected in the area of this crossing point and are combined behind the crossing point with the individual rope A**1** or B**1** which has passed through the crossing point without deflection.

[0030] Each material rope A and B preferably contains more than two individual ropes, preferably up to six individual ropes, wherein preferably at least one individual rope of a material rope passes through the crossing point without directional change whereas at least one individual rope of a material rope is deflected in the area of the crossing point.

[0031] According to the invention, each individual rope passing through a crossing point without directional change can be deflected in the area of the next crossing point or in the area of the crossing point after next.

[0032] In the state of rest, the material ropes A and B meet each other in the area of oppositely situated crossing points at an angle α of 15° to 90°, preferably 30° to 70°.

[0033] In the case of material ropes meeting each other in the area of a crossing point at an angle α of approximately 60°, for example, the deflection angle of one of the ropes is in the range of $\alpha/2=30°$ resulting in a minimal material-protective bending stress of the material ropes and the individual ropes.

[0034] Each material rope A and B may contain individual ropes and also individual threads made of textile material, synthetic and/or natural fibers as well as mineral fibers, especially basalt fibers, and individual wires, wire bundles, wire strands or wire cords made of metal, in particular steel or aluminium Each individual rope may contain a plurality of filaments and/or wires that are stranded. braided. twisted or laid largely parallel to each other.

[0035] According to FIG. **1**, the crossing points are at a distance "x" in a first direction in the range of 130 mm-160 mm, preferably 145 mm, and, in the other direction, at a distance "y" of 60 mm-80 mm, preferably 70 mm. The average diameter of each individual rope is preferably 2.5 mm-4 mm, especially 3 mm, wherein other dimensions are possible according to conditions of use.

[0036] The manufacture of the net may be performed on a buttonhole braider.

[0037] The individual ropes and the material ropes, i.e. the net, may be stabilized by a finishing agent. For example, thermoplastics may be used for stabilizing the mesh crossing points or/and the ends of the net.

[0038] According to a preferred embodiment of the invention, the net contains mesh crossing points which are glued, welded and. or clamped to each other.

[0039] The meshwork structure of the net is preferably Raschel knitted.

What is claimed is:

1. A net as safety or catching net for securing rocks and rock slopes, falling rock, mudflow or similar natural hazards, the net comprising filament yarns selected from the group of yarns that is consisting of multi-filament yarns and monofilament yarns and combinations thereof, the yarns combined together free of knots.

2. The net according to claim **1**, containing high module polymer fibers.

3. The net according to claim **1**, containing high performance polyethylene fibers, especially UHMW-PE fibers.

4. The net according to claim **3**, wherein the filaments have a filament tensile strength of 3,000 N/mm^2 to 4,000 N/mm^2.

5. The net according to claim **1**, comprising a net tensile strength >150 kN/m.

6. The net according to claim **1**, containing twisted yarns having titers of 1,200 dtex-1,800 dtex, preferably 1,400 dtex to 1,550 dtex, especially 1,500 dtex.

7. The net according to claim **1**, containing a coating for abrasion-protective and UV-protective purposes.

8. The net according to claim **1**, containing stainless steel fibers, natural fibers or mineral fibers or combinations thereof.

9. The net according to claim **1**, comprising material ropes, wherein two material ropes each meet at a mesh crossing point, respectively, and wherein

(a) each material rope (A, B) is comprised of at least two, preferably up to six, individual ropes (A**1**, A**2** or B**1**, B**2**),

(b) at least one individual rope (A**1** or B**1**) of each material rope (A or B) passes through a mesh crossing point without directional change,

(c) while at least one individual rope (A**2** or B**2**) of each material rope (A or B) is deflected at this mesh crossing point and is brought together with an individual rope (B**1** or A**1**) of the other material rope (B**2** or A**2**) passing through this mesh crossing point without directional change.

10. The net according to claim **9**, wherein the individual ropes (A**1**, A**2**, B**1**, B**2**) contain mineral fibers.

11. The net according to claim **9**, wherein the individual rope (A**1** or B**1**) passing without directional change through a first mesh crossing point is deflected in the area of a following second mesh crossing point and meets with an individual rope which has been deflected in the area of a preceding mesh crossing point so as to change its direction.

12. The net according to claim **9**, comprising polygonal meshes, especially tetragonal or hexagonal meshes, or rhomboidal meshes.

13. The net according to claim **9**, wherein in that in the state of rest the material ropes (A, B) cross each other at an angle α of 15° to 90° in the area of the mesh crossing points.

14. The net according to claim **13**, the angle α amounts to 30° to 70°.

15. The net according to claim **9**, wherein each individual rope (A**1**, A**2**; B**1**, B**2**) consists of a plurality of individual threads, which particularly are stranded, braided, twisted or are laid largely parallel to each other.

16. The net according to claim **9**, consisting of a meshwork of crossing material ropes (A and B) containing textile material.

17. The net according to claim **9**, wherein the individual ropes (A**1**, A**2**, B**1**, B**2**) contain textile material.

18. The net according to claim **9**, wherein the individual ropes (A**1**, A**2**, B**1**, B**2**) contain synthetic fibers; natural fibers; or synthetic and natural fibers.

19. The net according to claim **9**, wherein the individual ropes (A**1**, A**2**, B**1**, B**2**) contain mineral fibers.

20. The net according to claim **9**, wherein the individual ropes (A**1**, A**2**, B**1**, B**2**) contain wires, wire bundles, wire strands, wire cords, preferably made of steel or aluminium.

21. The net according to claim **9**, wherein the material ropes (A, B) are stranded, braided or laid largely parallel to each other.

22. The net according to claim **9**, wherein each material rope (A, B) consists of a plurality of individual ropes (A**1**, A**2**, B**1**, B**2**) which are stranded, braided, or laid largely parallel to each other.

23. The net according to claim **9**, comprising individual ropes (A**1**, A**2**, B**1**, B**2**) containing filaments of different materials selected from the group consisting of polymer fibers, natural fibers, mineral fibers, and individual wires, comprised of stainless steel or aluminium.

24. The net according to claim **1**, containing protective elements for the fiber-protective fastening to slope areas to be secured by means of clamping elements and/or rod anchors.

25. The net according to claim **1**, containing mesh crossing points which are glued, welded and/or clamped together.

26. The net according to claim **1**, comprising a Raschel knit structure.

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