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(54) A method for reinforcing a covering layer on ground.

(57) The invention relates to a method for reinforcing a covering layer (1) on ground (2) wherein the upper part (3) of the layer (1) comprises a pourable and self-hardening mixture (e.g. bituminous concrete), by a) placing at least one reinforcement net (5) on the supporting surface or foundation of the ground and b) then applying a binding layer (6) consisting of a self-hardening material of sufficient thickness and density so that the net (5) is enclosed in the layer (6) and c) after at least partial hardening of this binding layer (6) for anchoring the net, applying the pourable self-hardening mixture to constitute the upper part (3) of the covering layer and compacting the covering thus formed.

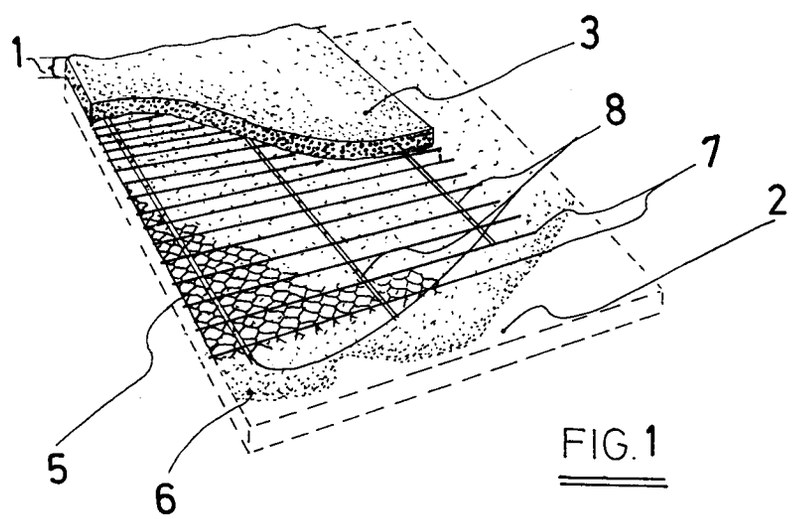

FIG.1

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The invention relates to a method for reinforcing a covering layer of ground by fixing at least one reinforcement net to a supporting surface or foundation of the layer to be reinforced or strengthened and by then applying a covering layer of sufficient thickness to the foundation so that the reinforcement net is completely imbedded in the layer. The covering layer consists of a slightly porous pourable self-hardening mixture, such as bituminous concrete. After pouring, the layer is compressed by rollers.

Such a method for reinforcing or strengthening ground, in particular roads, is already known.

A reinforcement net that is being utilized with success for implementing such a method is sold by N.V. BEKAERT S.A. under the name "MESH TRACK". "MESH TRACK" is a mesh or netting braided from galvanized steel wire that is reinforced at regular distances with a three-wire strand. The hexagonal meshes of this net are formed by twisting the wires together, the three-wire strands being arranged at regular distances from one another in the twisted sections thus formed. Plastic mats or nets can also be utilized.

For the reinforcement of a covering layer of ground, for example a road, in which this layer consists of bitumen, asphalt or similar material containing hydrocarbons (in short : asphalt roads), coils of reinforcement net are rolled out in the longitudinal direction on the ground foundation and fixed to it with nails in order to hold the reinforcement net in place during the application and rolling of the covering layer and to ensure a good bonding between foundation and asphalt. Suitable pieces of reinforcing nets can also be cut from a net coil and successively deposited in a transverse orientation on the ground.

One disadvantage of the method described above is the expensive and time-consuming operation of fixing such a reinforcement net to the foundation. This is the case in particular for the fastening of a "Mesh Track" netting. For fixing such a reinforcement net braided of steel wire to the foundation, clamps and/or hooks are used that are clamped over the wires or the strands of the net and are fastened to the foundation by means of plugs and pins. For fastening plastic nets, a gravel cover is usually utilized, i.e. a sufficiently thick layer of crushed rock is deposited over the nets.

From EP 0015432 a method is also known for fixing an elastic net to a foundation and then, for example, pouring sand over it to form a floor covering for indoor sport rooms.

It is an object of the invention to avoid this rather laborious net fixing procedure by providing a new method for securing a reinforcement net to a foundation. It is thus an object of the method to realize a strong and durable - but especially an easy and economical bound between the foundation and the reinforcement net. At the same time, of course, a satisfactory reinforcement effect must be assured for the self-hardening mixture of the covering layer that is to be poured.

Surprisingly, it has now been established that the application of a particular self-hardening binding layer of small thickness over and around the reinforcement net fulfills these objectives. The binding layer should preferably adhere well to the foundation and the reinforcement net must be sufficiently enclosed in this layer. By preference, the material of the binding layer will also adhere well to the net and will also enable a firm bonding with the upper layer of the covering which is to be poured. A relatively dense (i.e. non porous) binding layer, moreover, will protect the net even more and therefore increase the durability of the reinforcement.

The invention thus provides in principle a method for reinforcing a covering layer of ground in which the upper part of the covering consists of a pourable self-hardening mixture.

According to the invention, at least one reinforcement net is first placed on the supporting surface or foundation of the ground and then a slightly viscous pourable binding layer of a self-hardening material of sufficient thickness and density is applied so that the net is embedded or enclosed in the layer and isolated from the air. After at least partial hardening of this binding layer, a pourable self-hardening mixture is applied to form the upper part of the covering layer and the covering layer thus formed is compacted. Before applying the covering layer, the binding layer already present is in general not previously compressed or compacted.

The composition of the binding layer is selected such that it can fully spread out at temperatures lower than 80 degrees C (e.g. at 10 to 25 degrees), whereby irregularities and cracks in the foundation surface are effectively filled up. At the same time, the net is firmly enclosed and anchored in a dense layer, which in this way protects the net and resists water penetration and thus the possibility of being undermined or washed away.

Naturally the composition of the binding layer to be applied constitutes an important element of the invention. When the upper part of the covering layer is a layer of bituminous concrete (usually applied hot), the binding layer will by preference be a slightly viscous bituminous mortar that contains a powdered mineral filler, sharp sand and possibly natural sand and crushed rock. The granule thicknesses in this mixture generally vary between zero and 7 mm. The mortar to be formed is composed of 100 parts by weight of this mineral granular mass mixed with 10 to 18 parts by weight of a cationic bitumen emulsion and about 1 to 4 parts

by weight of an emulsion destabilizer (dissociation accelerator, such as cement) which enables the gradual elimination of the water phase from the mixture to bring about its hardening. One to two parts of the accelerator is usually sufficient. The freshly prepared bitumen emulsion generally contains about 60 % bitumen and 40 % water. The weight of the binding layer is somewhere between 5 and 40 kg per m^2 of foundation surface area, and preferably between 8 and 20 kg/m^2. The binding layer can comprise also less than 5 % wght of finely divided fibers of steel, polypropylene or other reinforcing fibers such as 8 % wght of Dramix® steel fibers or 1 % wght of Duomix® fibers (Duomix and Dramix are trade mark names of N.V. Bekaert S.A.).

At least a part of the sharp sand, as well as the crushed rock, may originate from limestone, porphyry or other minerals. The mineral filler is in powder form. According to the generally known needle penetration test, the hardness of the bitumens utilized can be selected between, for example, 40 and 200, and preferably between 70 and 150.

The percentage weight of the filler powder (powder thickness smaller than 0.08 mm), together with the other particles with a granule size of less than 2 mm (i.e. that fall through a sieve with square mesh holes having a surface area of 4 mm^2), will amount to at most 65 % of the total amount of mineral particles in the binding layer and, by preference, less than 50 %.

During the elimination of the water phase a residual bituminous binding agent, in fact, forms between the mineral particles. The binding layer is sufficiently hardened for the upper layer to be applied when the residual bituminous binding agent content is between 6 and 18 % by weight of the binding layer and, by preference, between 8 and 16 % by weight.

The invention also relates to the covering layer itself which is obtained according to the method and characterized, among other things, by particularities relating to the applicable reinforcement nets. The largest transverse dimension of the meshes of the net should be at least one time the mean thickness of the largest solid pieces present in the upper part of the covering layer and, by preference, even more than two times this thickness. In one preferred embodiment the reinforcement net will contain steel wire. Certain types of braided steel wire mesh (e.g. with hexagonal meshes, such as "MESH TRACK") are well suited.

The invention will now be further explained on the basis of the attached drawings.

Figure 1 shows in perspective a part of an area of ground in which the covering layer, reinforcement net and foundation are represented and

Figure 2 relates to an accompanying cross-section.

One preferred embodiment of the covering layer 1 represented in figure 1 includes a reinforcement net 5 that consists of a braided steel wire netting with hexagonal mesh: "Mesh Track". The hexagonal meshes are created by intermittent mutual twisting together of neighbouring longitudinal wires, whereby reinforcement elements 7 in the form of strands are inserted in the twisted sections at regular distances from one another running in the transverse direction. The longitudinal wires and the strands 7 are preferably made of steel wire and the wires are preferably galvanized. The longitudinal wires can, for example, have a nominal diameter of 2.45 mm, while the wires of the three-wire stands 7 have a nominal diameter of 3 mm. The meshes can, for example, have the following dimensions : 118 mm between the twisted sections in the longitudinal direction and 80 mm between the twisted sections in the transverse direction. The strands 7 are inserted at a distance of 225 mm from one another. All the dimensions given above are given only as examples. The reinforcement net 5 can also be equipped with longitudinal elements 8. These elements 8 can also be steel wire or strands of steel wire ; they can also be made of strip steel. Elements 7 and 8 can cross one another at a nearly perpendicular angle.

The reinforcement mesh 5 can also be made of plastic or of plastic-coated steel wires. Plastic mesh with thickened crossing points, for example the TENSAR or HATELITE types (trade mark names), are also suitable: the crossing points here are thus thicker than the connecting segments of the net between these crossing points.

The method according to the invention is described below. A reinforcement net is first rolled out onto the support surface of the foundation 2 of ground, for example a road, onto which an upper layer 1 must be applied (see figure 1). In order to make the net as even and flat as possible, a roller or similar means can be driven back and forth over it. This foundation 2 can, for example, be an old existing road.

According to the invention the mixture for a binding layer 6 of sufficient thickness is now applied over the net 5, so that the net is sufficiently enclosed in the layer 6. The mesh pattern of the net 5 is preferably still to be recognized after the mixture of layer 6 is poured (and spread out).
After a sufficient curing time, by preference a couple of hours, and without compressing layer 6, the upper layer 3, for example of bituminous concrete, can be applied. The application of the upper layer 3 (asphalting) proceeds without any problems. With an adjusted composition of the binding layer, it is

perhaps possible even one hour after the application of the layer 6 to start with the application of the upper layer.

It is clear that by the use of this binding layer 6 for fixing the reinforcement net 5, the cost for fixing the net 5 decreases markedly, which makes the use in the reinforcement of asphalt very attractive. Moreover, this reinforcement method makes it possible to keep the final thickness of the upper layer to be applied 1 to 2 cm lower than with a net fixation by means of hooks or clamps. At the same time, therefore, there is a saving on material.

The composition of the binding layer 6 will of course be adjusted in accordance with the nature of the foundation surface, of the net 5 to be imbedded and of the composition of the upper layer 3. Among other things, it can be advisable to put, for example, 0.1 to 0.2 kg/m^2 of a bitumen emulsion on the foundation surface beforehand as an adhesive for the binding layer. If so desired, elastomers can be added to the bituminous mortar of layer 6 in order to increase its elasticity and shock absorption capacity. Corrosion inhibitors can also be mixed in for an increased protection of the wire mesh against corrosion.

Example

A steel wire net 5 of the "Mesh Track" type from N.V. Bekaert S.A. (with the construction and mesh dimensions as given on page 5) is rolled out on a cleanly scraped concrete road. The net is then compacted very flat and even against the road surface. Subsequently a bituminous mortar 6 as binding layer, based mainly on porphyry is poured in the usual manner, with a composition of 15 parts by weight of bitumen emulsion and 1 part by weight of dissociation accelerator per 100 parts of granulate mass. The granulate mass consists of at least 50 % by weight of granules of thicknesses of between 2 and 7 mm (sometimes between 2 and 4 mm), approximately 10 % filler powder and the rest being mineral granules of thicknesses between 0.08 mm and 2 mm. The viscous pourable or flowable mixture is spread out to a thickness of 5 to 7 mm. This means about 15 kg binding layer material per m^2 of road surface area. The net is thereby completely covered with and embedded in the layer 6, which is now left untouched for at least one hour so that the water will gradually be eliminated from the layer 6 and evaporate, resulting in a hardened layer 6 with a nearly dry surface. The meshes of the net 5 can still be recognized through the binding material cover. This indicates that the mortar 6 is sufficiently fluid to penetrate through and around the wires of the "Mesh Track" net 5. The surface of the layer 6 is thus slightly profiled in the ribbed pattern of the Mesh Track netting.

It is known that with asphalt reinforcement in road construction keeping the reinforcement immovable and well anchored during the pouring of the asphalt (upper layer 3) is a critical point. Indeed the nets often have the tendency to bulge locally between the forward moving pouring area behind the truck and the compacting machine following immediately after it. According to the invention it now appears, however, that during the application of the upper asphalt layer 3 the hardened binding layer 6 is sufficiently stable to prevent this tendency to bulge and to hold the mesh immovable and flat. This is at the same time an indication that a strong bonding with the road surface is assured.

Ordinary hot bituminous concrete is now poured on top of the hardened binding layer and rolled out to a thickness of 4.5 cm. This thickness of the total cover 1 (upper layer 3 plus binding layer 6) is thus a good 1 cm less than with the traditional hardened asphalt layers for hard/solid road foundations. The somewhat profiled surface of the binding layer 6 promotes the mechanical anchoring of layer 3 to layer 6 and thereby the reinforcement of the upper asphalt layer 3 and prevents undue horizontal sliding of this upper layer under the weight of the vehicles. If so desired, a thin film of a bituminous glue can be sprayed on the binding layer before the bituminous concrete is poured in order to further promote a durable bonding of the two layers to each other.

The invention is also applicable for the reinforcement of other ground or areas of land such as, for example, industrial floors, parking lots, wharfs, airfield pavements, etc., where on a solid foundation a binding layer 6 is applied with a composition as described above (and with a thickness, for example, of 2 to 3 cm) and reinforced with a net 5. Then as upper layer 3 a cement concrete layer, for example, can be poured and spread out to a thickness of 8 to 15 cm, possibly with the insertion of a suitable layer of glue. This cement concrete layer can, for example, include fibers or pieces of steel wire (Dramix trade mark) as reinforcement (so-called fiber concrete).

Claims

1. A method for the reinforcement of a covering layer (1) of ground (2), wherein the upper part (3) of the layer (1) consists of a pourable, self-hardening mixture, by
   a) placing at least one reinforcement net (5) on the supporting surface or foundation (4) of the ground and
   b) then applying a slightly viscous flowable binding layer (6) composed of a self-hardening material of sufficient thickness and density so that the net (5) is enclosed in the

layer (6) and,
c) applying the pourable self-hardening mixture to constitute the upper part (3) of the covering layer (1) after at least partial hardening of this binding layer (6) for anchoring the net and compacting the covering thus formed.

2. A method according to claim 1 wherein the upper part (3) is a bituminous concrete, characterized in that the binding layer to be applied is a bituminous mortar, containing a mixture of 10 to 18 parts by weight of a cationic bitumen emulsion and 1 to 4 parts by weight of an emulsion destabilizer with 100 parts by weight of a mineral granule mass in the form of a powder-like filler, sharp sand, optional natural sand and crushed rock, wherein the granule thickness of these mineral particles is between zero and 7 mm and wherein the dissociation destabilizer enables the water phase to be eliminated gradually from the mortar in the process of hardening through the formation of a residual bituminous binding agent between the mineral particles.

3. A method according to claim 2, wherein the content of the residual bituminous binding agent amounts to between 6 and 18 % by weight of the binding layer after hardening and before the application of the upper layer (3).

4. A method according to claim 1, wherein the amount of binding layer applied is between 5 and 40 kg/m^2 of foundation surface area.

5. A method according to claim 4, wherein the amount of said binding layer applied is between 8 and 20 kg/m^2 of foundation surface area.

6. A reinforced covering layer (1) obtained with the method according to claim 1 or 2, characterized in that the largest transverse dimension of the meshes of the net (5) amounts to at least one time the mean thickness of the largest solid pieces present in the upper part (3) of the covering layer.

7. A covering layer according to claim 6, wherein the reinforcement net (5) comprises steel wire.

8. A covering layer according to claim 6, wherein the reinforcement mesh is a braided steel wire mesh.

9. A covering layer according to claim 8, wherein the braided net comprises reinforcement elements (7) running transversely in a number of its braided crossing points.

10. A covering layer according to claim 9, wherein the reinforcement elements (7) are strands of steel wire.

11. A covering layer according to claim 6, wherein the reinforcement mesh is a plastic net.

12. A covering layer according to claim 6, wherein the amount of particles of a thickness less than 2 mm in the mineral granule mass amounts to at most 65 % by weight.

13. A covering layer according to claim 6, wherein this amount of particles amounts to at most 50 % by weight.

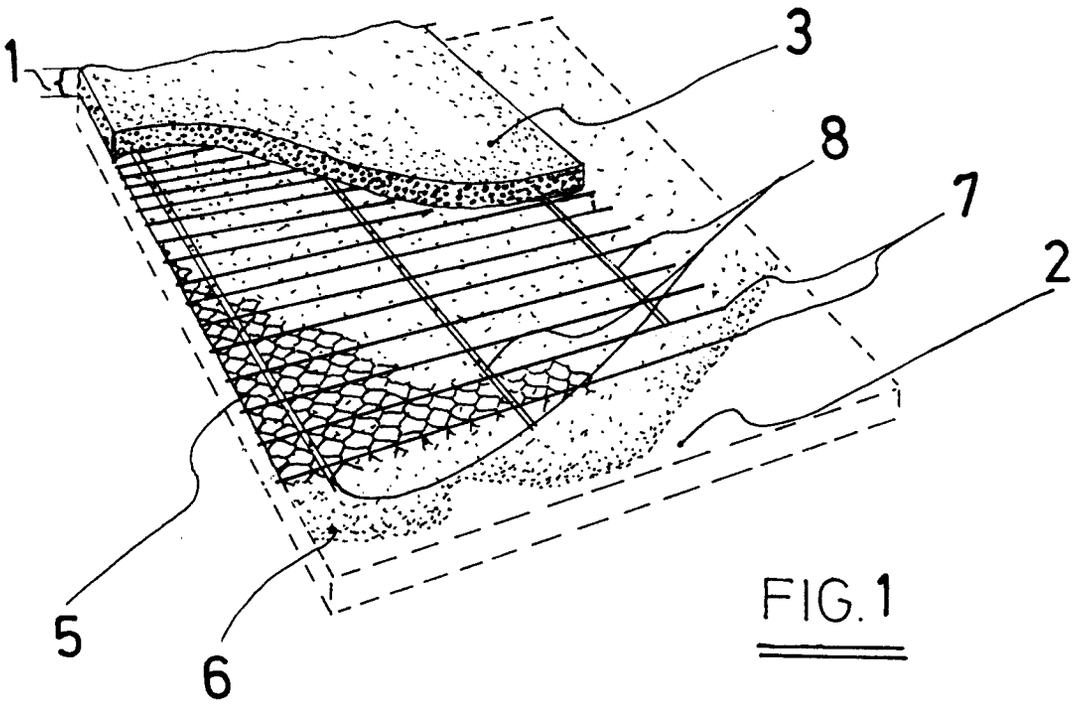

FIG.1

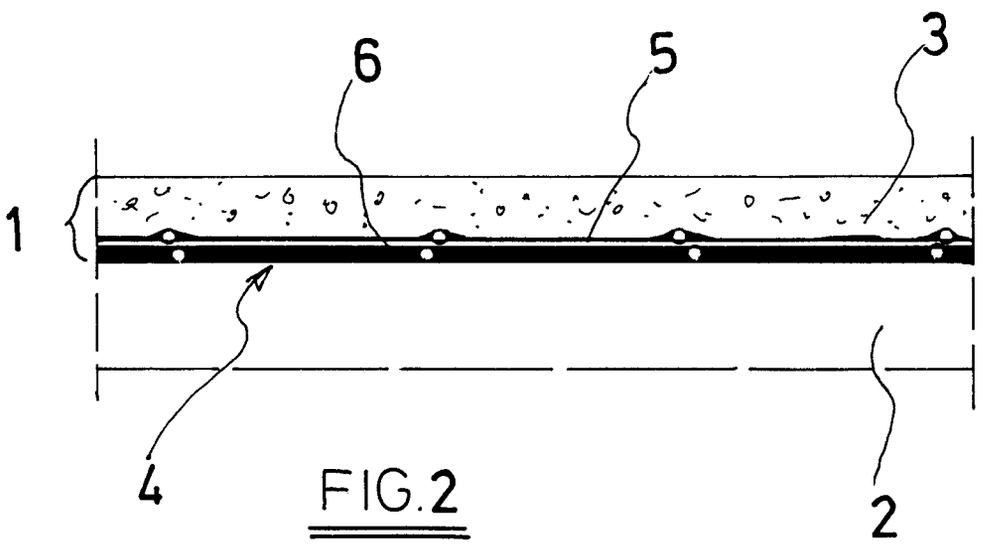

FIG.2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 20 0790

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	WEGEN. vol. 62, no. 2, February 1988, BOSKOOP NL pages 31 - 35; SCHOFFELEN: 'toepassing asfaltwapening in proefvakken' * page 32, right column, line 9 - page 33, right column, line 25 *	1,4-11 2	E01C11/16 E01C7/32
X	HIGHWAYS. vol. 58, no. 1957, January 1990, CROYDON GB pages 12 - 14; BUIST & INESON: 'geogrids in reinforcing asphaltic pavements' * page 12, column 3, line 5 - column 4, line 18 *	1,4,5,11 6	
Y A	EP-A-0 373 041 (SCREG) * column 2, line 17 - line 22; example 1 *	6 1	
X	WEGEN. vol. 62, no. 4, April 1988, BOSKOOP NL pages 23 - 24; STOELHORST: 'astamat:wapen tegen asfaltvervorming' * page 24, left column, line 4 - line 13 *	1 6	TECHNICAL FIELDS SEARCHED (Int. Cl.5) E01C
Y A	US-A-1 707 939 (MCKENZIE) * page 2, line 118 - page 3, line 32; figures *	6 1	
A	FR-A-2 615 520 (ENTERPRISE LEFEBVRE) * claims 1,6-11 *	2,3	
A	US-A-1 862 011 (GAGE)		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20 MAY 1992	DIJKSTRA G.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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