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(71) Applicant: **ZNAČKY MORAVA A.S.** [CZ/CZ]; Čsl. armády 1112/27a, CZ-79401 Krnov (CZ).

(72) Inventor: **TAVANDZIS, Andreas**; Ježník 20/2319, CZ-79401 Krnov, Pod Bezručovým vrchem (CZ).

(74) Agent: **KENDEREŠKI DUŠAN**; Lidická 51, CZ-60200 Brno (CZ).

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(54) Title: METHOD OF ANTI-SKID ADAPTATION OF WEARING COURSE OF THE ROADWAY

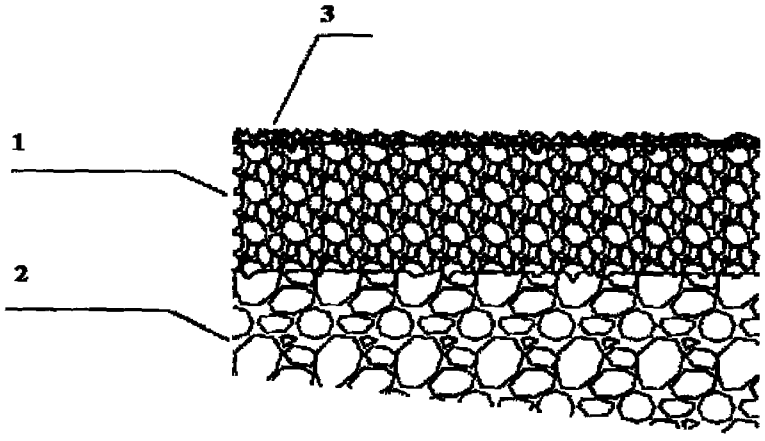

Fig. 1

(57) Abstract: Method of anti-skid adaptation of the wearing course (1) of the roadway wherein the base of the wearing course, without its destruction, is at first deeply cleaned, roughened and homogenized, after which the upper surface of the wearing course adapted in this way is fixed by means of binder and subsequently during the binder curing the sanding with abrasive is carried out, wherein the tensile adhesion of the binder is greater than 2 MPa.

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METHOD OF ANTI-SKID ADAPTATION OF WEARING COURSE OF THE ROADWAY

Field of the Invention

The invention relates to a method of anti-skid adaptation of the wearing course of the roadway on the road sections susceptible to forming of ice phenomena.

Background of the Invention

Due to the operation, the current state of the wearing courses of the road in relation to the skid resistance is unsatisfactory. Wear of the roads is often visible at first glance; evidential statistics only underline this problem. Microstructure providing sharpness of the surface is fading away as well as the macrostructure, which defines the drainage properties of the road. It is evident from the statistics that 30 – 40 % of traffic accidents occur at the 3 % of the overall length of our road network. From long-term research performed by e.g. Institute of Road Structures at VUT Brno it is apparent that the accident rate at worn spots of the road is almost five times higher than at the unproblematic places. In case of humidity or ice on the road the danger of accidents rapidly increases. Critical points occur at temperatures around 0 °C on roads especially on bridges or access and downhill ramps of crossroads or road section located near watercourses. These are problematic especially in terms of formation of icing under the conditions, when there is no risk of formation on adjacent roads or eventually the roadway freezes faster at such places. The negotiability of the road at the given weather depends on the construction of the road as well as on its maintenance. Icing phenomena (icing, black ice, rime) usually occur at the air temperature of +3 to -12 °C. Waters freezes only at the temperature below freezing point, however, the ground surface and objects on it may be cooler than air. This occurs especially on bridges. Bridge structures have different thermal accumulation and conductivity compared to adjacent natural body and they are cooler due to the airflow under the structure as well as due to the evaporation of air humidity from the structure. The roadway on steel bridge decks use to freeze most often. The formation of icing and especially black ice is really quick at the commencement of rain or mixed precipitation on cooled surface and in case the driver has no available information

about its formation, icing or black ice may be unexpectedly surprising. They can appear unexpectedly locally, wherein the best conditions for their formation are especially on bridges, further at worn-out longitudinal tracks and in the woods. Another icing phenomenon affecting the safety on roads is icing. The formation of icing is mostly strongly determined by local conditions, especially in case of icing on the road. The most influential factor for driving safely is the roughness of the road surface, as a factor mitigating the risk of skidding. An extreme caution and reducing the driving speed is needed. The icing on the roadway might not even be seen easily. The road sections with an increased danger of icing formation are usually indicated by blue traffic buttons, what is often unsatisfactory. Moreover, the problem of bridge constructions affecting the safety of their usage as well as their durability is the risk of corrosion of the construction itself due to the possibility of water leakage through the upper layers of the road to the dysfunctional or damaged layers of waterproofing and leaking to the bridge structure connected with it. The corrosion processes in concrete are always associated with the presence of moisture, therefore the free water penetration into the structure is the source of most problems. Besides that, the water leakage into the dysfunctional waterproofing and bridge joints needs to be addressed immediately because it directly threatens both, concrete and reinforcing and pre-stressing reinforcement and the overall durability of the bridge construction. The formation of cracks, potholes in the upper layers of the roadway rapidly increases the danger of skidding. Moreover, on the road it is always necessary to count with the presence of chemical de-icing agents, which make the whole situation even more difficult.

The CZ patent application 297 352 discloses a method of repairing faults in the wearing course of the roadway. The method is carried out so that at first the wearing course is cleaned by steel shot blasting while at the same the resulting waste is sucked, subsequently it is penetrated by binder, after which during the drying of binder the first sanding of the surface using coarse filler measuring 1/3 of the fault width is carried out, which is incorporated into the fault of the wearing course by rotational grinding and subsequently the second sanding of the surface using finer filler measuring 1/6 of the fault width is carried out and the process of rotational grinding is repeated, after which the reparation ends with sanding using light binder

with grain size 0,03 mm to achieve a lighter shade of the wearing coarse of the road surfacing.

Patent application no. NL9101645 discloses a road surfacing, especially road surfacing for building constructions, such as for example bridges and viaducts. The surfacing comprises the surface layer of solid grains, which are individually coated by plastic binder so as the solid grains would bind together, wherein it further comprises a lower layer made of flexible material. The solid grains are made of material which is selected from a group consisting of organic, inorganic, synthetic, ferrous and non-ferrous, thermosetting or thermoplastic additives or combinations thereof, such as for example sand, gravel, corundum or aluminium oxide. The binder is selected from a group consisting of thermosets, thermoplastics or thermoplastics which are derived from thermosets.

Summary of the Invention

The invention provides a method of adaptation of the road surfacing by means of which several crucial factors important for the increasing of safety of the operation on the treated roadway are influenced. It relates especially to the adaptation of the roadway at risky sections, i.e. bridges, ramps, near watercourses or in the woods. The primary aim of the roadway adaptation according to this description is increasing the roughness of the surface above the standard required value $Fp \geq 0,6$ and thus reducing the risk of skidding at forming icing.

The above described drawbacks are eliminated by the method of adaptation of the road surfacing characterized in that, at first, the base of the wearing course, without its destruction, is deeply cleaned and roughened to unify the properties of the macrostructure of the wearing course of the road surface, after which the upper surface of the wearing course adapted in this way is fixed by means of binder and subsequently during the binder setting the sanding with abrasive is carried out, wherein the adhesion of the binder is defined by the force required for tearing the binder from the wearing course, in this case the binder applied on the wearing course shows resistance to tensile stress greater than 2 MPa.

Homogenization of the wearing course base in the form unification of properties of the macrostructure of the wearing course surface of the roadway is achieved particularly by its deep cleaning and roughening of the whole surface to be treated. This substantially means a creation of a surface with similar macrostructure properties. Thanks to the performed homogenization the binder surface shows similar physical parameters on the whole treated area, especially the width of the surface. For optimal adhesion, the effect of the deep cleaning of the road surfacing using water jet is also important.

The principle of the adaptation of the road (roadway) according to the invention is the creation of macrostructure, which consists of binder comprising abrasive with grain size of 0,3 – 4 mm. Macrostructure is applied on the cleaned wearing course of the roadway, of which the surface is deeply cleaned and roughened evenly over its entire surface, what ensures its homogeneity. Such method of adaptation of the road surfacing reduces the risk of vehicle skidding both during freezing and wet conditions, leading to better removal of water between the roadway and the tire than on the untreated roadway.

Using the abrasive with grain size of 0,3 and 4 mm has such an effect that the grain with greater size extending above the road surface further provide the desired roughness of the surface. Thanks to deeper macrostructure, the formation of dangerous icing is delayed. More freezing moisture fits into the free space in the macrostructure than in the untreated roadway. More time is needed for formation of the even layer of ice. The extension of the time after which the road is suitable for operation is achieved. Moreover, the later formation of icing creates a time delay to perform winter maintenance.

The forming icing is also less consistent than it is on the smooth surface and it is disrupted more easily by passing vehicles. Improving the macrostructure of the surface causes the inconsistency of icing.

No less important feature increasing the safety on risky sections is the consequence of the restriction of the amount and density of water mist emerging under wet conditions during driving – the principle is smaller area of the water surface when in contact with a tire (incoherent surface thanks to macrostructure) and thus

smaller surface tension of the water when in contact with a tire – less water on tires, less water on lifting of the tire. This improves the visibility under wet conditions.

By this attribute we restrict other dangerous factor and that is formation of aquaplaning. For example, when applying "FROST GRIP" system a larger amount of water is needed to form an even layer of icing or coherent water surface. The above described faster water drainage from underneath the tire further eliminates the risk of this phenomenon.

For safe operation of the road, an optical warning for driver about the possible danger of icing formation is important. For this reason the binder together with abrasive is applied in blue colour, which is already embedded in the traffic signs familiar to the drivers warning them against the possible danger, for example blue traffic buttons, blue verge posts or blue reflectors in the guardrails. Optical flat notice about such adapted wearing course of the roadway in blue colour is much more effective. Moreover, it may be supplemented by a symbol A24 of icing directly on the adapted surface.

Applying the method of adaptation of the wearing course on the bridge construction provides lesser probability of creation of cracks as well as of the corrosion of the bridge structure. By means of such roadway adaptation it is possible to create chemical-resistant and impermeable macrolayer preventing the penetration of moisture over the wearing course even in case that macrolayer is applied along the whole width of the roadway.

Description of the Drawings

Anti-skid adaptation will be further illustrated by means of drawings, where the fig. 1 shows a section of wearing course of the roadway provided with macrostructure.

Description of Preferred Embodiments

The method of anti-skid adaptation of the wearing course of the road according to the present invention will be further illustrated by means of respective example with reference to the corresponding drawings.

In general it may be concluded that the present method of the road surfacing adaptation is performed as follows; at first the wearing course is deeply cleaned, roughened, by means of which a homogenous surface is achieved, than the penetration of such cleaned surface is carried out and further the macrostructure itself is applied on the wearing course of the road, i.e. at first the binder is layered and in a short time period the abrasive is incorporated into the binder (for example crushed stone).

The preparation of the road surface, which usually consists of the wearing course 1 and the base course 2 needs to be always performed consistently to meet the requirement of maximum cohesion of the macrostructure with the roadway. It is therefore necessary to non-destructively deeply clean and roughen the wearing course 1 and achieve a coherent surface structure, i.e. homogenize it. It is possible to use "PeelJet" technology for this purpose. This technology uses the energy of water jet for roughening and wide range of the machine for optimal homogenization. An advantage of this technology is that it allows the operator at work to adjust the working parameters to the quality of the roadway as well as to the actual requirements on the wearing course 1 with precision. An apparent advantage is a large number of high-pressure nozzles and their distribution. The nozzles are densely arranged on the rotating disc instead of rotating bars with a small number of nozzles. Also crucial is the working width of 2,2 m, which provides not only the work productivity but also the above described homogeneity of the surface of the wearing course 1. The trajectory of the movement of the disc with bars above the roadway is one of the adjustable parameters. The path of the disc may be discontinuous for an optional value, what has the effect especially on the intensity of roughening. For preparation of the base a working pressure of 1500 – 2500 bar is used in nozzles.

"PeelJet" technology does not leave any abrasives on the roadway and does not use any additives, which would disrupt the subsequent adhesion. The water used in the system for deep cleaning (roughening) is sucked back to the machine.

After adjusting the surface of the wearing course 1, it is necessary to perform penetration recommended by the manufacturer of the basic binder in case of installation on the concrete. A modified epoxy resin, the properties of which meet the fracture adhesive test (ČSN EN ISO 4624), is the most commonly used as a binder,

wherein the adhesion of the binder is defined by a force required to tear the binder from the wearing course, in this case the binder applied on the wearing course shows resistance to tensile stress bigger than 2 MPa.

The principle of the adhesive test of the tested product according to (ČSN EN ISO 4624) is based on that the tested product or coating system is applied in uniform thickness on the planar test sample of the same surface structure. After drying/curing of the coating system, the tested pieces are glued directly on the surface of the coating. Once the glue hardens, the set of glued pieces is attached on a suitable tensile test apparatus. The glued set is subjected to controlled tensile force (fracture test). The force needed to tear the coating/base is measured. The tensile stress is increasing at a rate less than 1 MPa/s perpendicular to the plane of the coated base so that the tearing of the test assembly happens within 90 s since the initiation of the stress.

The binder is laid for performing the eventual penetration. An alternative to the said modified epoxy resin is two-component methacrylate elastic material and thermoplastic may also be an alternative. The edges defining the treated area are covered by a tape, which is removed after the application.

Binders are being laid according to the instructions for the particular material. This relates to two-component materials with binder (activator) to the base ratio as well as to the recommended temperatures for heating the thermoplastic. Immediately after laying of the binder in a solid layer the abrasive is added to it. The binder has to meet the requirement for the tensile adhesion to be greater than 2 MPa.

High quality crushed stone with fraction of 2 – 4 mm and minimum hardness of the Mohs scale with a rating of 6 is used as an abrasive. Corresponding is granite or corundum. The purity, precision of fractions, quality of its colour and its colour stability is crucial in relation with crushed stone. The abrasive is applied manually or mechanically. A sufficient amount of abrasive needs to be laid to create an even macrolayer **3** with an excess and the binder areas would not stand out.

After settling of the laid binder, the compression of the abrasive using a roller (manual, mechanical) is carried out and after curing or hardening (the time depends on conditions of installation) the mechanical removal of free residues is carried out

using mechanical or manual sweeping machine or manual tools, to finish the macrolayer 3.

The created texture has a medium depth of the macrostructure determined by volumetric method (ČSN EN 13036-1) greater than 2 mm and the value of friction coefficient determined by a pendulum (ČSN EN 13036-4) PTV 85 greater under dry conditions and PTV 70 greater under wet conditions.

Industrial Applicability

The method of anti-skid adaptation of wearing course of the roadway may be used wherever the danger of icing, rime or black ice emerges. Especially in terms of bridges, access or downhill ramps at elevated crossing and in forest road sections.

LIST OF REFERENCE SIGNS

1 Wearing course of the roadway
2 Base course of the roadway
3 Macrolayer

CLAIMS

1. Method of anti-skid adaptation of wearing course of the roadway **characterized in that** the base of the wearing course, without its destruction, is at first deeply cleaned and roughened to unify the properties of the macrostructure of the wearing course, after which the upper surface of the wearing course adapted in this way is fixed by means of binder and subsequently during the binder setting a sanding with abrasive is carried out, wherein the adhesion of the binder is defined by the force required for tearing the binder from the wearing course, in this case the binder applied on the wearing course shows resistance to tensile stress greater than 2 MPa.

2. Method of adaptation of the wearing course of the roadway according to claim 1, **characterized in that** the overall penetration of its entire surface is carried out before application of the binder on the concrete surface of the wearing course.

3. Method of adaptation of the wearing course of the roadway according to claims 1 or 2, **characterized in that** the subsequent fixation is carried out by means of binder based on modified epoxy resin or two-component methacrylate elastic material or thermoplastic.

4. Method of adaptation of the wearing course of the roadway according to claim 1, **characterized in that** the abrasive as well as the binder is coloured blue.

5. Method of adaptation of the wearing course of the roadway according to claim 1, **characterized in that** the abrasive consists of crushed stone with fraction of 2 – 4 mm and minimum hardness of the Mohs scale with a rating of 6.

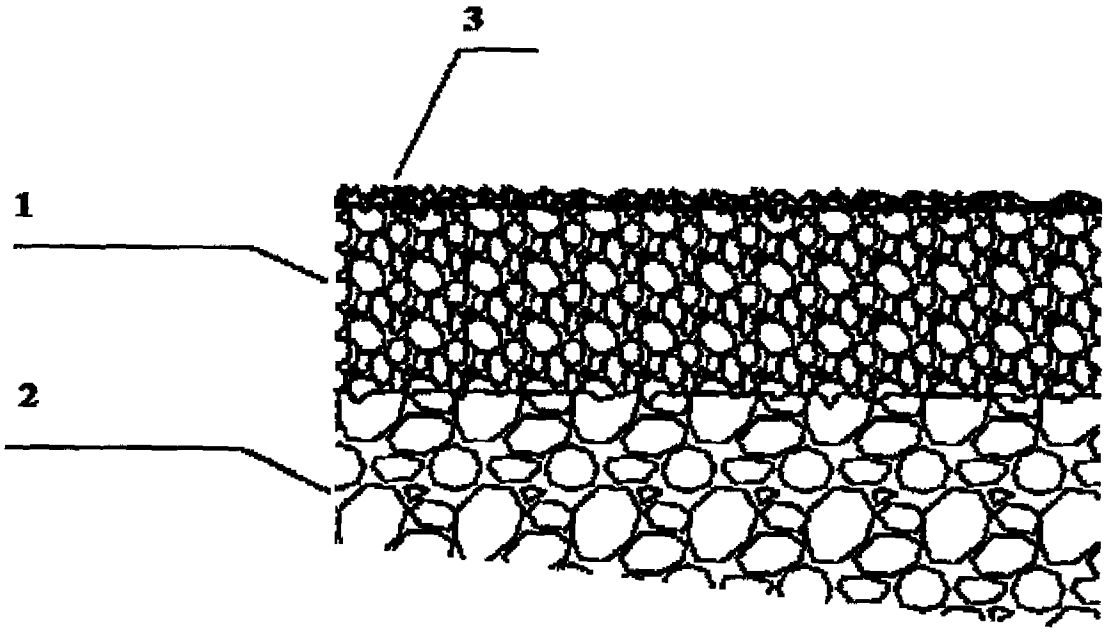

Fig. 1

INTERNATIONAL SEARCH REPORT

International application No
PCT/CZ2015/000088

A. CLASSIFICATION OF SUBJECT MATTER
INV. E01C11/24 E01C7/08 E01C7/35
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E01C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2014/002140 A1 (OSADA GIKEN CO LTD [JP]; OSADA SHOMA [JP]) 3 January 2014 (2014-01-03) figures 1,2 the whole document	1-5
X	GB 1 384 385 A (MIDLAND YORKSHIRE HOLDINGS LTD) 19 February 1975 (1975-02-19) page 1, line 11 - line 18 page 3, line 110 - line 114 claim 14 the whole document	1-5

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

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"&" document member of the same patent family

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Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Klein, A

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/CZ2015/000088

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2014002140 A1	03-01-2014	KR 20150023067 A	04-03-2015
		WO 2014002140 A1	03-01-2014
GB 1384385 A	19-02-1975	NONE	