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## (54) Method for constructing durable skid-resistant surface layers on roads.

(57) A method for applying a skid-resistant surface layer to roads involves the application of a layer of chippings which is then covered by a layer of bituminised sand. This sand fills the voids between the chippings such that, during subsequent compression with a roller, the chippings cannot rotate and remain in a random orientation. The resulting surface layer contains a relatively large proportion of chippings having a sharp or pointed edge uppermost and thus possesses good skid-resistance properties.

The method may be adapted either for use in the re-surfacing of an existing road or for applying a skid-resistant surface during the construction of a new road.

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# METHOD FOR CONSTRUCTING DURABLE SKID-RESISTANT SURFACE LAYERS ON ROADS

The present invention relates to a method for applying a durable skid-resistant surface layer to a) existing roads and b) new roads under construction.

Skidding represents a major hazard on roads. It is not only a problem in wet weather but can also occur during dry conditions. Particularly in countries which experience long periods of hot dry weather, oil and dust may settle on the road surface and have a polishing effect which results in an extremely slippery surface. Road surfaces must have a rough texture in order to reduce this problem. Also, in wet weather, a rough texture on a road surface decreases the possibility of vehicles skidding due to surface water by an effect called "aquaplaning". These considerations are obviously particularly important on roads carrying high speed traffic.

A road can be made more skid-resistant by fixing,on the surface thereof, a layer of chippings which have a high resistance to the aforementioned polishing effect. Several methods for doing this have been proposed. For instance, in the case of re-surfacing an existing road, a technique known as "surface dressing" may be employed.

According to this method, a bituminous binder film is sprayed onto the existing surface, a layer of stone chippings is spread over the binder and a roller is then used to embed the chippings sufficiently in the binder. This used to be a relatively cheap and effective method of applying a skid-resistant surface. However, in recent years there has been a marked increase in the weight of vehicles, particularly of lorries and their loads, and a general rise in the volume of traffic. Under such conditions, the chippings tend to

sink further into the binder or underlying asphalt causing the binder to be squeezed up and around said chippings. As a result, the chippings are generally re-orientated and become completely embedded so that a completely smooth road surface results. In addition, dust settling on the road surface can become embedded in the binder, thereby increasing its volume and causing it to swell up around the chippings. This latter effect is a particular problem in countries such as Greece, which experience long dry summers during which significant amounts of dust from surrounding countryside settles on the surface of roads. Such phenomena,known generally as "fatting up", obviously play a significant role in reducing the skid-resistance of the road surface. For this reason,this method of surface dressing is no longer used on roads carrying heavy traffic.

There are other known methods for applying a skid-resistant surface layer, both to existing roads and during the construction of new roads. According to one such technique, a top layer composed of chippings together with a small amount of sand is applied in a single operation and then rolled with a heavy roller to form an open asphaltic course. A major disadvantage of this method is that the initially random orientation of the chippings is destroyed by the heavy roller which tends to turn the chippings over so as to leave their flat surfaces uppermost. Obviously, the chippings are most effective in providing skid-resistance properties when an edge or peak is uppermost.

An alternative method involves the application of a dense asphaltic layer (sometimes known as bituminous concrete). This is a mixture composed of more than 50% of sand and less than 45% of chippings - the remainder being bitumen. If left

without further treatment, the composition forms upon rolling a layer in which about 90% of the surface comprises sand and bitumen and which is smooth. For this reason,in order to provide the necessary surface texture high quality chippings, precoated with bitumen, are spread on the surface of the still warm and soft asphalt and are embedded therein by means of a heavy roller. This is widely used in the United Kingdom where it is known as rolled asphalt with embedded chippings. It will be appreciated that this method has the same disadvantage as that described in the preceding paragraph, i.e. the random orientation of the chippings is destroyed by the use of the heavy roller.

I have discovered that the above-mentioned disadvantages of the conventionally laid road surfaces are overcome by the present invention.

According to one embodiment of the present invention there is provided a method for applying a durable skid-resistant surface layer to an existing road which comprises the steps of:-

i) applying a layer of binder to the existing surface;

ii) spreading a layer of chippings over the binder;

iii) rolling with a lightweight roller;

iv) spraying a bituminous binder onto the chippings;

v) spreading a layer of bituminised sand over the surface such that the voids between the chippings are filled and their tops completely covered, and

vi) compressing the structure with a vibrating roller.

According to a further embodiment of the present invention there is provided a method for applying a durable skid-resistant surface layer during the construction of a new road which comprises the steps of:-

i) spreading a layer of chippings precoated with bitumen over the still warm asphaltic course of the road;

ii) rolling with a lightweight roller;

iii) spreading a layer of bituminised sand over the surface such that the voids between the chippings are filled and their tops completely covered, and

iv) compressing the structure with a heavy roller or lightweight vibrating roller.

The invention will now be described in greater detail with reference to the accompanying drawings, in which:-

Figures 1 to 6 illustrate the steps of the embodiment of the present method whereby a skid-resistant surface layer is applied to an existing road.

Considering the case where a new surface is to be applied to an existing road (Figures 1 to 6). The existing surface (1) is cleaned as far as possible and a layer of a binder(2) is applied, typically by spraying. The binder is preferably warm cut-back bitumen (i.e. a solution of bitumen in an organic solvent) or emulsified cut-back bitumen. Alternatively, tar may be used as the binder. In a preferred embodiment, an adhesion agent containing dipolar molecules is added to the binder. Suitable agents are well known to those skilled in the art and will not be described in detail here.

A layer of chippings (3) is then immediately spread over the binder (Figure 1). The chippings typically have a diameter of from 5 to 30 mm, although this is not critical. They may comprise, for example, crushed natural stones or industrial waste, such as metallurgical slags, waste products from the porcelain and refractory brick industries or possibly artificially produced stony materials resulting from the calcining or coagulation of inorganic materials such as bauxite, clays and sands bonded with cementaceous material. Chippings having a nominal size of 19 mm (as defined by British Standard BS 1984) are particularly suitable for use in skid-resistant road surfaces. The chippings should be precoated with bitumen if it is desired to keep the road open to traffic while the re-surfacing work is being carried out; otherwise, the chippings may be used uncoated.

The surface is then rolled by a lightweight non-vibrating roller (4) as shown in Figure 2. At this stage, further chippings may be applied if the road surface is required to possess special additional properties. For example, the use of chippings having a high "polished stone value" will produce an increased resistance to the aforementioned polishing effect, while the presence of lightly coloured chippings will increase the luminosity of the eventual road surface.

The chippings are next sprayed (5) with a bituminous binder (Figure 3). This is usually preferably in the form of a cationic emulsion, the charges serving to keep the particles of bitumen in suspension.

However, there are circumstances in which the use of an anionic emulsion may be preferred. Cationic emulsions will coagulate and can be applied in any weather conditions. However, if a period of dry weather can be guaranteed then an anionic emulsion may be applied. Such emulsions do not coagulate, the water therein simply being allowed to evaporate - hence the requirement for dry conditions. Anionic emulsions have the advantage that they can be easily prepared on site, while preformed cationic emulsions may have to be transported some distance.

The emulsion may be diluted with water if chippings of a small size are to be coated by the spray.

A layer of bituminised sand (6) is then spread, either manually or more preferably by mechanical spreaders, over the surface such that the voids between the chippings are filled and their tops completely covered, preferably to a depth of from 1 to 3 mm. The bituminised sand comprises a mixture of sand and filler treated with bitumen. The sand may consist of crushed sand produced from rocks containing minerals of a hardness over 5 MOHS and contain filler, preferably in a proportion between 15 and 30%, or of a mixture of natural or crushed sand with pulverised fuel ash and bottom ash (from furnaces) or volcanic ashes, or of granulated slag with the above-mentioned fillers. The mixture is treated with bitumen, preferably in an amount of from 2 to 3% by weight of bitumen. This treatment may be carried out either in an asphalt mixing plant or in a suitable mixer with cut-back bitumen.

The structure is then compressed with a vibrating roller (7) as shown in Figure 4. The intensity of vibration of the roller is chosen to be appropriate to produce the desired crushing strength

in the chippings. The more exacting the traffic conditions (for example, the weight and volume of the traffic, the presence of steep hills and sharp bends) the higher is the required crushing strength in the chippings and so the more intense will be the vibration applied.

Immediately after this rolling, the road may be fully re-opened to traffic. The crust that has been formed by the compressed bituminised sand is gradually worn away by the tyres (8) of passing cars (Figure 5). This material collects at the roadside where it may easily be recovered and, if desired, used again in re-surfacing work.

The resulting skid-resistant surface layer is shown in Figure 6.

According to a further embodiment, the method of the present invention may also be used to apply a durable skid-resistant surface layer during the construction of a new road. In this case, a layer of chippings precoated with binder of the type described above is spread over the still warm asphaltic course of the road structure. The chippings are usually spread after an initial light rolling of the asphaltic course, although if the asphaltic layer is relatively thin this may be omitted. The chippings are of the same material as described above, but must in this case be precoated.

The layer of chippings is then lightly rolled without vibration, preferably using a rubber-tyred roller.

A layer of bituminised sand, of the composition and quantity described above, is next spread over the surface. This is then compressed with either a vibrating lightweight roller or a non-vibrating heavy roller. It will be understood by those skilled in the art that a "lightweight roller"

as referred to herein, is one of less than about 5 tons in weight, whilst the term "heavy weight roller", as used herein, refers to a roller weighing at least about 8 tons.

The road is then opened to traffic and the crust of compressed bituminised sand is worn away,as described above, to reveal the skid-resistant surface layer.

The methods of the present invention possess a number of advantages over the previously known methods.

Considering firstly the method in which a new surface layer is applied to an existing road,it is notable that only a small amount of binder needs to be applied to the existing road surface. Even taking into account the bituminous binder subsequently applied to the chippings, the total amount of binder used is significantly less than in known methods. It might be expected that such a reduction in the binder content would lead to problems and, indeed, this would be the case if binder were used alone. However, the application of the bituminised sand results in the formation of a bituminous mortar (9) which holds the chippings securely in place. This mortar is much stronger than pure binder alone and remains firm during even the hottest weather conditions.

Furthermore, the mortar is saturated with sand and so is unable to adsorb the dust and fine sand which settles on the road surface during the summer and which would otherwise cause the problem of "fatting up" described previously.

An additional problem encountered when using a traditional method to re-surface an existing road is the difficulty in making the new surface adhere to the existing surface. Undulations frequently

appear in the new surface as a result of it sliding. An extremely unusual feature of the present method is the use of a vibrating roller so as to create very high local compression stresses at the points of contact of the chippings with the existing road surface (known as "the pavement"). If the aggregate of this pavement is of a stone weaker than that of the chippings, small cavities will be formed in the surface of the pavement. The "stone flour", produced by the crushed aggregate at the point of contact, collects in these cavities. In conventional methods this would be a point of weakness (due to a loss of adhesion) and so the use of vibrating forces, which produce this effect, is traditionally avoided. However, in the present method the use of a vibrating roller is specified because any stone flour produced is absorbed to form a strongly adhesive mortar(10). The temporary presence of the crust of compacted bituminised sand provides the necessary protection to allow this mortar to set while the road is fully open to traffic.

A major advantage of the present method, whether being used to re-surface an existing road or to apply a skid-resistant surface layer during the construction of a new road, is that the chippings cannot rotate during the final rolling stage. As previously described, a serious disadvantage with conventional procedures is that the initially random orientation of the chippings is destroyed by the use of a heavy roller. The chippings tend to be turned over so that a flat face is uppermost and their effectiveness in providing skid-resistance is reduced. However,in the method of the present invention the bituminised sand fills the voids between the chippings and thereby prevents them from rotating during the rolling operation.

Accordingly, a much larger proportion of the chippings remain orientated with an upward pointing edge or peak and the resulting surface layer has markedly increased skid-resistance properties.

The following advantages are also achieved by the method of the present invention:

i) The desired macrotexture (mean texture depth) of the surface layer can be achieved with the use of a smaller size of chippings. This results in a saving of materials and also reduces the risk of damage to windscreens caused by loose chippings of a large size being thrown up by traffic using the road.

ii) The peaks and edges of the chippings on the road surface are more numerous and pronounced, thereby producing a higher degree of skid-resistance than would be expected from the "polished stone value" (P.S.V.) of the material. In this way, chippings of a lower P.S.V., applied by the present method, produce a surface layer of the same skid-resistance as would be achieved with the use of more expensive chippings of a higher P.S.V. applied by a conventional method.

iii) The useful life of the surface treatment is extended because the bituminous binder is protected from the effects of weathering by the presence of the bituminised sand. As described above, this forms a mortar and this mortar has the effect of sealing the pores in the surface layer, thus preventing the penetration of water.

iv) It is not necessary for the aggregate of the top course to have a high resistance to polishing, but only a good resistance to

crushing and abrasion in order to be able to hold the embedded chippings in place.

CLAIMS

1. A method for applying a durable skid-resistant surface layer to an existing road which comprises the steps of:-

   i) applying a layer of binder to the existing surface;

   ii) spreading a layer of chippings over the binder;

   iii) rolling with a lightweight roller;

   iv) spraying a bituminous binder onto the chippings;

   v) spreading a layer of bituminised sand over the surface such that the voids between the chippings are filled and their tops completely covered, and

   vi) compressing the structure with a vibrating roller.

2. A method as claimed in claim 1, wherein the binder of step i) comprises warm cut-back bitumen or emulsified cut-back bitumen or emulsified plain bitumen.

3. A method as claimed in claim 1 or claim 2, wherein the binder is applied together with an adhesion agent.

4. A method as claimed in any of the preceding claims, wherein the chippings are precoated with bitumen before being spread over the surface.

5. A method as claimed in any of the preceding claims, wherein the bituminous binder of step iv) applied to the chippings is in the form of a cationic emulsion.

6. A method for applying a durable skid-resistant surface layer during the construction of a new road which comprises the steps of:-

i) spreading a layer of chippings precoated with bitumen over the still warm asphaltic course of the road;

ii) rolling with a lightweight roller;

iii) spreading a layer of bituminised sand over the surface such that the voids between the chippings are filled and their tops completely covered, and

iv) compressing the structure with a heavy roller or lightweight vibrating roller.

7. A method as claimed in any of the preceding claims, wherein the chippings comprise crushed natural stones, industrial waste products or artificially produced materials.

8. A method as claimed in any of the preceding claims,wherein the bituminised sand comprises natural or crushed sand or bottom ash or slag and a filler and the mixture has been treated with bitumen.

9. A method as claimed in claim 8, wherein the filler comprises pulverised fuel ash.

10. A method as claimed in claim 8 or claim 9, wherein the filler is present in a proportion of from 15 to 30% and the bitumen at from 2 to 3% by weight.

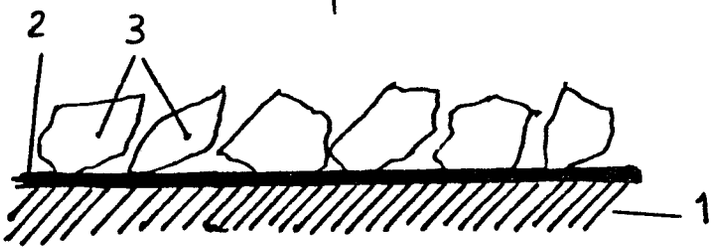


FIGURE 1

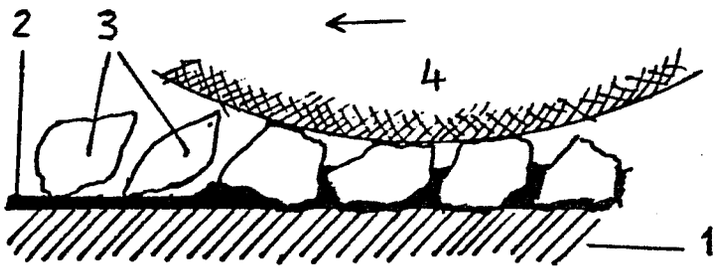


FIGURE 2

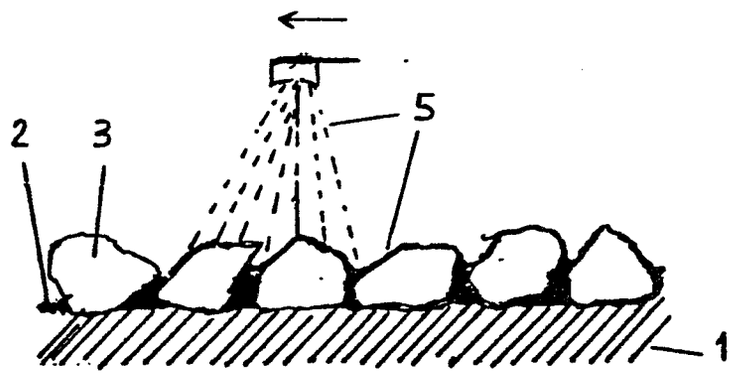


FIGURE 3

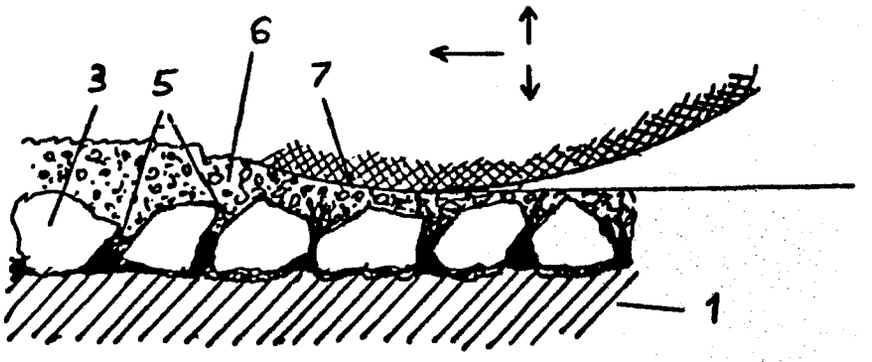


FIGURE 4

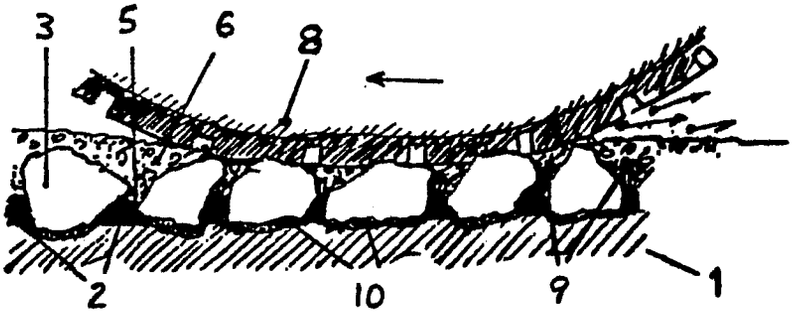


FIGURE 5

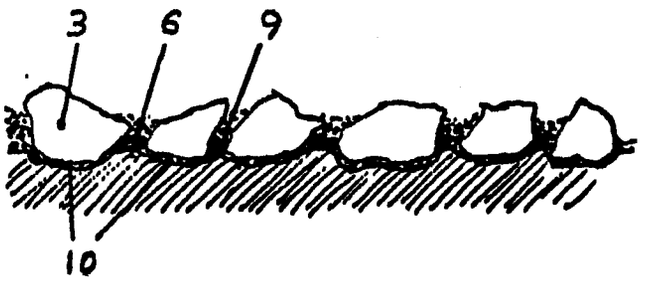


FIGURE 6