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(19)



(54) PROCESS FOR SURFACING ROADS USING A BITUMINOUS COMPOSITION/

(71) We, TOBISHIMA KENSETSU KABUSHIKA KAISHA, a company organised and existing under the Laws of Japan, of 3-28, Kudan-Minami 2-Chome, Chiyoda-ku, Tokyo-To, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to the use of a bituminous composition for providing a so-called asphalt road, i.e. a road having a surface layer obtained by binding aggregate such as macadam and sand with bitumen, of an improved anti-skidding effect on vehicles running therein, high stability and weatherability.

Typical properties required of road surfacing materials are, for example, stability, durability, wear resistance, non-fluidity, and, *inter alia*, an anti-skidding or anti-slipping effect. The anti-skidding effect is greatly required because skidding accidents are rapidly increasing in recent years due to the development of highway systems and large-sized or high-speed vehicles.

Factors which may have caused vehicles to slip were unsatisfactory surface conditions of the road, i.e. roughly finished road surfaces, an inappropriate type of surface treatment, unsuitable blending of surface materials, and the like.

More particularly, the corrugation formed on the treated surface, the road surface not having a coefficient of friction of at least 0.4, improper longitudinal and transverse gradient and an awkward arrangement of road curves, or flushing after completion of road surfacing, i.e. exudation of an excess asphalt over the road surface in, for instance, a summer season, has caused vehicles to slip on the road.

Further, weather conditions augment skidding and vehicles are liable to skid when the road surface is in a wet state due to an elevated temperature, or when soil particles carried onto the road surface are converted into colloidal or paste form at the beginning of rainfall.

Furthermore, a hydroplane phenomenon sometimes occurs when vehicles run at a high speed on the road saturated with rain water.

In practice, vehicles skid or slip more often due to a combination of some of the causes mentioned above than due to a single cause.

However, the most effective anti-skidding means is to increase the frictional resistance, and there have been several attempts to achieve this by introducing improvements in surfacing materials.

As one of such attempts, a surface layer of so-called fine-particle asphalt concrete produced by binding aggregate of a relatively fine particle size with an asphalt has been widely used. The surface treatment of roads with this layer of fine-particle asphalt concrete requires no further sealcoat or overcoat to be applied onto a surface of bitumen, and can provide high stability and skid resistance while being economical.

However, this type of surface treatment has the drawback that the coefficient of friction of the road thus surfaced is as high as about 0.6 immediately after completion of road surfacing but gradually decreases with time after the road is opened to traffic.

On the other hand, there are methods wherein the following surface layers are provided on the surface layer of fine-particle asphalt concrete described above:

- (a) an anti-skidding layer of coarse-particle asphalt concrete having a thickness of 2 to 3 cm and comprising a relatively uniform particle size of aggregate containing less than about 30% by weight of particles having passed through a 2.5 mm sieve;

(b) a layer of bauxite emery, which is aggregate having a high hardness and large specific gravity, bonded onto the surface layer with a binder such as a synthetic resin, or

(c) a surface layer of silica sand for providing improved wear resistance.

However, the anti-skidding layers applied onto the road surface according to these methods were not satisfactory in respect of durability since they were gradually peeled off and caused potholes after the road was opened to traffic.

In particular, the anti-skidding layer of bauxite emery bonded with a binder is liable to be peeled off due to cracks caused by the difference in modulus of elasticity between the binder *per se* and the asphalt concrete, and, once this layer is peeled off, vehicles may more often skid on the road thus surfaced. In addition, this method involves higher cost.

Also known is a method wherein rubber asphalt comprising asphalt and styrene-butadiene rubber (SBR) or other rubbery high polymers blended therewith is used as a binder to improve surfacing materials.

It is true that, by using such rubber asphalt as a binder, a surfacing material of improved stability or anti-deformation property, toughness and tenacity can be obtained, but no improvement has been shown in the anti-skidding effect thereof. Further, according to this method wherein rubber asphalt is used, the desired advantages cannot be obtained unless the rubber component is incorporated in the rubber asphalt at a level as high as 6 to 10% (percentages herein and hereafter being based on weight) and thus this method is not economical.

An object of the present invention is to provide an improved bituminous composition which imparts high durability and a high anti-skidding effect to asphalt roads while eliminating the drawbacks and difficulties inherent in the above-stated anti-skidding methods and ensuring an economical surface treatment of road sites.

We have found that, by adding to bitumen, such as asphalts, rosin or rosin derivatives in addition to a rubbery high polymer, it is possible with a low rubber content generally of 1 to 5% by weight to obtain stability, toughness and tenacity as high as, or higher than, those obtained from a conventional bituminous composition comprising 10% of a rubber component, and to secure improved elongation and toughness at low temperatures, wear resistance and weatherability, and further to provide asphalt-surfaced roads having a skid resistance or number of 70 to 85 which is increased by about 20 to 35% as compared with that of a typical conventional asphalt-surfaced road ranging from 55 to 60 and which is not appreciably lowered with time.

Thus, the present invention provides a process for surfacing roads, which comprises surfacing roads with a composition comprising aggregate, and a binder comprising bitumen, rosin or a rosin derivative, and a rubber.

The nature and principle, and the various features and advantages of the present invention will be more clearly understood from the following detailed description of the invention followed by a specific example.

The bitumen used in the present invention is not substantially different from that used in ordinary asphalt-surfaced roads.

More specifically, the bitumens which may be used in the present invention include natural asphalt, or petroleum asphalts such as straight and blown asphalts, petroleum and coal tars, mixtures thereof, and emulsions of these bitumens, among which those having a penetration of 80 to 100 are preferably used, penetrations herein and hereafter being based on the measurement conditions of 25°C, 100 g and 5 min.

To any of these bitumens are generally added 3 to 20%, preferably 5 to 15%, by weight, based on the weight of the binder, of rosin or rosin derivatives.

Below 3%, the rosin or rosin derivatives added are generally not sufficiently effective, while above 20%, no significant increase in advantageous effects is shown, and the addition of rosin or rosin derivatives in such an amount would thus result in disadvantages from an economic standpoint.

If 3% or more rosin or rosin derivatives are added, it is possible to obtain such a high frictional resistance as at least 70 of BBN as measured by a portable skid resistance tester of the British type.

The rosin derivatives include, for example, rosin soap, rosin esters such as ester gum, hydrogenated rosin and polymerized rosin, or any mixture thereof.

The rubber which may be used in the present invention includes natural rubber, or synthetic rubbers such as SBR (styrene-butadiene copolymer rubber), acrylonitrile-butadiene copolymer rubber, polybutadiene rubber, styrene-butadiene-acrylonitrile copolymer rubber, polychloroprene rubber and ethylene-propylene-diene co-

polymer rubber, or any mixture thereof, and may be incorporated as a pre-formed emulsion of any of these materials.

A preferred example of the rubber is SBR in the form of aqueous emulsion sold by Japan Synthetic Rubber Co., Ltd., under the tradename of JSR Roadex.

These rubbers are generally used in an amount of 1 to 5%, preferably 2 to 3%, by weight based on the weight of the binder.

Below 1%, the composition is not sufficiently improved in stability, toughness, tenacity and brittleness at low temperatures. Above 5% no significant increase in effects is shown and the addition of rubber in such higher amounts is, therefore, not economical.

In order to mix rosin or derivatives thereof and a rubber with bitumen, mixing under heat or mixing at ambient temperatures may be employed.

Mixing under heat involves melting solid or semi-solid bitumen such as asphalts at a temperature of, for instance, about 130 to 165°C, and adding to the bitumen thus melted rosin and other additives.

Mixing at ambient temperatures involves adding rosin and other additives to liquid bitumen, such as emulsified bitumen, tar and cut-back asphalt, at ambient temperatures or at an elevated temperature of up to about 60°C.

Rosin or rosin derivatives may be added to bitumen in the form of powder or emulsion.

The bituminous composition thus obtained and used as a binder in the present invention may optionally comprise 0.5 to 2.0% by weight of a reduction product of diallylamine or phenothiazine as an antioxidant or a stabilizer against degradation. Phenothiazine may be added to prevent degradation or rosin powder during storage.

The bituminous composition used in the present invention may further comprise, optionally, low molecular weight polyolefins, for example, atactic polypropylene which is a by-product of isotactic polypropylene to obtain improved toughness, tenacity and elongation, of sulphur to obtain increased stability and durability.

The bituminous composition used in the present invention is added to aggregate as a binder to form a surfacing material.

The optimum content (%) of this bituminous composition in a surfacing material can be determined according to the Marshall or Harvard test method, and ordinarily 3.5 to 8% by weight is preferred.

Below 3.5%, the composition cannot have a sufficient binding strength of aggregate. Above 8%, the composition begins to flow and to suffer plastic deformation.

Aggregate can be chosen from those commonly used for road surfacing, irrespective of fine particles or coarse particles.

The aggregate preferably comprises at least 95% by weight of particles not exceeding 20 mm in particle size.

Heretofore, surfacing materials comprising limestone as aggregate were generally known to wear easily and to cause skidding. These drawbacks can be eliminated by the bituminous composition used in the present invention comprising rosin, rubber and bitumen which is highly permeable to limestone.

The surfacing material obtained can be used for applying either a one-layer surface or a multilayer surface onto road.

As set forth hereinabove, the surface layer obtained from the bituminous composition used in the present invention hardly softens or becomes corrugated under elevated temperature conditions, for example, in a summer season, or the bitumen itself seldom exudes through the road surface. For this reason, the road surface is maintained coarse and with a high frictional resistance which serves to prevent the skidding of vehicles.

Further, the rosin has a high affinity for asphalt and rubbery high polymers and enhances the affinity thereof for aggregate, thus ensuring a simplified surface treatment of road sites, and providing remarkably improved stability, i.e. shear resistance and resistance to deformation, toughness, tenacity and weatherability with the addition of a small amount of a rubber.

The present invention is now described in more detail with reference to the following example. This example is intended merely for illustrative purposes and is not intended to restrict in any way the scope of the invention or the manner in which it may be performed. The percentages are by weight unless otherwise indicated.

Example.

To straight asphalt (1) having the properties as shown in Table 1 below were added 10% of gum rosin and 2%, as a rubber content, of emulsified SBR (solid content 50%, pH 10.5, viscosity 225 cps at 25°C, and specific gravity (0.98) to prepare the binder of the present invention. The properties of the binder thus prepared

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are also listed in Table 1 below. Similarly, the properties of straight asphalt (2) which is commonly used for road surfacing are set forth in the same table.

TABLE 1: Properties of Binder

Properties	Straight asphalt (1)	Straight asphalt (2)	Binder of the invention
Penetration (25°C, 100g, 5 min) (% by length)	98	70.5	71
Softening point (°C)	46.0	46.8	47.8
Elongation (cm)	above 100 (at 15°C)	above 100 (at 15°C) 25 (at 10°C)	above 100 (at 10°C)
Evaporation loss (%)	0.06	0.04	0.095
Penetration after evaporation (%) (to original penetration)	83	85	87
Film evaporation loss (%)	0.173	0.095	0.153
Penetration after film evaporation (%)	67.2	77.3	88
Carbon tetrachloride, soluble (%)	99.98	99.99	99.81
Flash point (°C)	321	330	286
Specific gravity	1.028	1.029	1.030
Toughness (kg.cm)	—	38.7	87.8
Tenacity (kg.cm)	—	3.4	18.4

5 As will be apparent from Table 1 above wherein the toughness and tenacity of the binder used in the present invention and those of straight asphalt (2) are shown, the binder used in the present invention is far superior to straight asphalt (2). 5

10 The binder used in the present invention also exhibits very much higher toughness than that (ca. 50 to 60 kg.cm) of a binder comprising 10% of emulsified SBR obtained under similar conditions, and subsequently equal tenacity to that (ca. 15 to 20 kg.cm) of the latter binder. 10

15 The binder used in the present invention and the above-stated straight asphalt (2) were admixed each in an amount to reach 6.3% of the total weight, with fine-particle aggregate having the composition and particle size distribution set forth in Table 2 below to form the surfacing material in accordance with the present invention and an ordinary surfacing material, respectively. 15

The results obtained from the Marshall Test on these surfacing materials were as listed in Table 3 below.

TABLE 2: Composition and Particle Size Distribution of Aggregate

Type		Fine particle	Coarse particle
Composition (%)	JIS No. 5 Macadam (20 – 13 mm)	—	12.0
	JIS No. 6 Macadam (13 – 5 mm)	34.0	21.0
	JIS No. 7 Macadam (5 – 2.5 mm)	23.6	23.0
	Coarse sand	25.3	22.0
	Fine sand	11.6	16.0
	Stone powder	5.5	6.0
Particle size distribution (pass %)	25 mm	100	100
	20 mm	100	97.5
	13 mm	97.5	80.0
	5 mm	65.0	45.0
	2.5 mm	42.5	27.5
	0.6 mm	23.5	17.0
	0.3 mm	15.5	10.5
	0.15 mm	11.0	8.0
	0.075 mm	6.0	4.5

TABLE 3: Results of Marshall Test

Surfacing material	Volume cm ³	Density g/cm ³		Bitumen volume % (volume)	Voids % (volume)	VMA % (volume)	Percentage humidity %	Stability kg.	Flow value 1/100 cm.
		Found	Theoretical						
Present invention	496.1	2.335	2.442	14.3	4.4	18.7	76.5	977	28
Prior art	496.9	2.334	2.431	14.3	4.0	18.3	78.1	848	33

Footnote:

Binder: 6.3%

It is apparent from Table 3 above that the surfacing material used in the present invention has remarkably improved stability, i.e. resistances to shearing force and deformation caused by heavy loads of heavy-weight vehicles, while maintaining a stable flow value.

The stability obtained from the surfacing material used in the present invention, 977 kg, is even higher than that of a binder comprising 10% of SBR, 935 kg, obtained under similar conditions.

The surfacing material used in the present invention and the ordinary surfacing material described above were cut to dimensions of $150 \times 400 \times 50$ mm to prepare test samples.

The test samples thus prepared were subjected to the Ravelling Test at a temperature of -10°C and a rotation speed of 360 rpm for a period of 1.5 hours.

As a result, the abrasion loss of the ordinary surfacing material was 0.951 cm^3 , whereas that of the surfacing material used in the present invention was 0.431 cm^3 which showed a reduction to about 45%. Thus, it is apparent that the surfacing material used in the present invention is remarkably improved in wear resistance.

Further, three types of surfacing materials, i.e. the fine-particle surfacing material used in the present invention obtained according to the above procedure, a coarse-particle surfacing material used in the present invention and an ordinary coarse-particle surfacing material respectively obtained by admixing the binder of the invention and the straight asphalt (2) set forth in Table 1, each in an amount to reach 5.5% of the total weight, with the coarse-particle aggregate shown in Table 2, were applied to a part of a road course as a surfacing test.

The frictional resistance of roads respectively surfaced with these three types of materials was respectively measured by the trailer method (in accordance with ASTM E274-65T and E274-70). The results obtained from the road test at a velocity of 40 miles/h are as listed in Table 4 as follows.

TABLE 4

Road Surfacing Material	Coefficient of Friction		Skid Number (S.N.)
	Right Tire	Left Tire	
Fine-particle type used in the present invention	0.766	0.763	76.5
Coarse-particle type used in the present invention	0.714	0.710	71.2
Ordinary coarse-particle type	0.547	0.599	57.3

Footnotes:

(1) The values with respect to the surfacing materials used in the present invention are the average of those obtained by measurements repeated six times, and the values with respect to the ordinary surfacing material are the average of those obtained by measurements repeated twice.

(2) The test tires used were ASTM 750—14 Standard tires.

As noted from Table 4 above, the coarse-particle surfacing material comprising the binder used in the present invention was found to have an S.N. of 71.2 which is far higher than that of the ordinary surfacing material, i.e. 57.3, and the fine-particle surfacing material was found to have a still higher S.N., i.e. 76.5.

This is presumably because the road surface treated with the surfacing material used in the present invention is under the condition of scarcely causing skidding due to its agglutinated surface state, and a higher fractional surface can be obtained than might be expected from the coarseness of the road surface.

For reference, the abrasion loss of the tires of the trailer used in the test was so slight that substantially no abrasion loss was observed in each measurement.

WHAT WE CLAIM IS:—

1. A process for surfacing roads, which comprises surfacing roads with a composition comprising aggregate, and a binder comprising bitumen, rosin or a rosin derivative, and rubber.

2. A process as claimed in claim 1, wherein the binder comprises 3 to 20% by weight of rosin or a rosin derivative, 1 to 5% by weight of a rubber (solids content), and the remainder bitumen.

3. A process as claimed in claim 2, wherein the binder comprises 5 to 15% by weight of rosin or a rosin derivative, 2 to 3% by weight of a rubber (solids content), and the remainder bitumen.

4. A process as claimed in any of claims 1 to 3, wherein the bitumen is a natural or petroleum asphalt, a petroleum or coal tar, any mixture thereof or is incorporated as a pre-formed emulsion of any of these materials.

5. A process as claimed in any of claims 1 to 4, wherein the rosin derivative is a rosin soap, rosin ester, hydrogenated rosin or polymerized rosin, or any mixture thereof.

6. A process as claimed in any of claims 1 to 5, wherein the rubber is natural rubber, polybutadiene rubber, styrene-butadiene copolymer rubber, acrylonitrile-butadiene copolymer rubber, styrene butadiene-acrylonitrile copolymer rubber, polychloroprene rubber or ethylene-propylene-diene copolymer rubber, or any mixture thereof, or is incorporated as a pre-formed emulsion of any of these materials.

7. A process as claimed in any of claims 1 to 6, wherein the binder further comprises an antioxidant and/or a stabilizer against degradation.

8. A process as claimed in any of claims 1 to 7, wherein the surfacing composition comprises from 3.5 to 8% by weight of the binder.

9. A process as claimed in any of claims 1 to 8, wherein the aggregate comprises at least 95% by weight of particles not exceeding 20 mm in particle size.

10. A process as claimed in claim 1, substantially as hereinbefore described with reference to the Examples.

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