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(72) BURNS, BERNARD, US
(71) DEGUSSA-HÜLS AKTIENGESELLSCHAFT, DE

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(54) **LIANT D'ASPHALTAGE MODIFIE AU CAOUTCHOUC**
(54) **RUBBER-MODIFIED ASPHALT PAVING BINDER**

(57) Disclosed is an asphalt paving binder composition comprising asphalt cement, crumb rubber and polyoctenamer, the binder composition may be produced by adding the crumb rubber and the polyoctenamer while the asphalt cement is heat liquefied. The binder composition is useful in preparing an asphalt paving composition by mixing with an aggregate material. The polyoctenamer may crosslink the asphalt cement with the crumb rubber.

Abstract of the Disclosure

Disclosed is an asphalt paving binder composition comprising asphalt cement, crumb rubber and polyoctenamer, the binder composition may be produced by adding the crumb rubber and the polyoctenamer while the asphalt cement is heat liquified. The binder composition is useful in preparing an asphalt paving composition by mixing with an aggregate material. The polyoctenamer may crosslink the asphalt cement with the crumb rubber.

RUBBER-MODIFIED ASPHALT PAVING BINDER

Field of Invention

The invention relates to asphalt, or bitumen, paving composition that are modified by the addition of rubber, and particularly crumb rubber, such as ground tire rubber from discarded tires.

Background of the Invention

Conventional asphalt cement (AC) produced by a petroleum refinery must be modified to enhance its qualities as a binder. Asphalt cement derived from petroleum refining is a mixture of hydrocarbons and heterocyclic compounds, including asphaltenes and maltenes formed from polynuclear hydrocarbons of relatively high molecular weight. Asphalt varies depending upon its source, i.e., the crude oil and the refinery. An asphalt binder is defined as the substance used to hold together aggregate particles, e.g., crushed rock, stone, fillers, etc., and thereby form asphalt concrete.

Various modifiers have been disclosed and adopted for commercial use in an effort to improve the performance and extend the life of asphalt paving compositions. One class of material that has been added to the hot asphalt is polymer modifiers. One commonly used polymer that is added to the asphalt at high temperature is styrene-butadiene-styrene (SBS)

block co-polymer in a range that is typically less than 10% by weight of the asphalt binder mixture. Although certain physical properties and performance characteristics of the applied asphalt concrete are improved, the use of SBS has several drawbacks, including its insolubility in the asphalt and that it separates and rises to the top of the asphalt during storage unless the mixture is subjected to an appropriate type of mixing on a continuous basis. When used with crumb rubber (GTR), the asphalt-SBS mixture is subjected to an increase in viscosity during storage. A further drawback to the use of SBS as a modifier is that relatively higher levels of the polymer are required to achieve the same level of improvement in the U.S. federally-established Strategic Highway Research Program (SHRP) asphalt binder test ("PG") rating.

Polypropylene has also been used commercially as a modifier, but like SBS, this material does not form a true solution with the asphalt and if the mechanical stirring and/or recirculation of the mixture is discontinued or drops below a certain level, the polymer additive will separate to form a separate layer on the surface of the hot asphalt in the processing equipment.

Another polymeric material that has been suggested for use as a modifier of asphalt is styrene-butadiene rubber (SBR). However, the modified asphalt containing SBR produces a composition having relatively high tack which results in an

undesirable build-up of the material on paving machines, flights, hoppers, shovels and lutes. This effect is also manifested as a pick-up on a surface of a roller equipment when the hot concrete is being finished on a road surface which can on be mitigated by allowing the asphalt to cool to less than about 150°F (about 66°C) before being rolled. In addition, the finished paving concrete has a greater tendency to develop "spider webs", or fine surface cracks, under certain climatic conditions.

A variety of other polymers, including rubbery terpolymers have been disclosed as having utility as asphalt modifiers. For example, U.S. Patent 5,733,955 discloses the addition of a rubbery polymer as a modifier that is comprised of a conjugated diolefin monomer, a vinyl aromatic monomer, and isobutoxymethyl acrylamide that form the backbone of the polymer. An asphalt modifier is disclosed in U.S. Patent 5,773,496, that is a mixture of sulphur and a polymer comprised of a linear co-polymer that is a styrene-conjugated diene block co-polymer and a similar linear co-polymer of specified molecular weight. It does note appear that these or other polymeric modifiers have been adopted for use by commercial paving contractors.

A material that has been adopted for use as an asphalt cement modifier is crumb rubber. The principal source of crumb rubber in the United States and elsewhere throughout the world is ground tire rubber (GTR) from discarded tires. The U.S.

Federal Highway Administration (FHWA) has approved crumb rubber produced from scrap tire for use in highway pavements as a modifier for asphalt cement. The use of crumb rubber as a modifier for asphalt cement in place of other "virgin" polymeric modifiers has been hailed by some as a solution to the ever-growing problem of disposing of discarded tires in an ecologically acceptable and economical way.

Crumb rubber, or GTR, of varying particle sizes has been incorporated into the hot asphalt, cement, although relatively small particle sized materials of 40 mesh or smaller are preferred. Two basic types of crumb rubber are available and are identified by the processes of their respective manufacture. Cryogenic GTR is produced by shredding the tire into relatively large pieces and then subjecting the rubber to grinding under cryogenic conditions. Ambient warm-ground GTR is produced under non-cryogenic conditions. The cryogenic GTR exhibits a certain regularity of shape when examined by scanning electron microscope (SEM) techniques and reveals particles having generally planar surfaces of relatively low surface area, as might be expected from the fracturing of the cryogenically frozen crystalline tire rubber. In contrast, ambient GTR particles are irregular in appearance with extended tendrils resulting from the pulling apart and shredding of the rubber structure (as compared to cryogenic fracturing) and possess a

much higher surface area as compared to the particles produced by the cryogenic process.

The use of GTR as a modifier for asphalt cement that is used as a binder in paving compositions provides several advantages, including a more resilient road surface that flexes under the force of passing vehicular traffic to break up thin sheets of ice during formation. The road surface is also darker and therefore absorbs more of the sun's radiant energy to melt accumulating ice and to more quickly dry a wet surface. The addition of GTR also provides improved skid resistance. However, there are limited opportunities for a chemical bond to form between the asphaltenes and maltenes and the rubber particles and it is difficult to uniformly disperse the GTR in the asphalt cement. As a result of these chemical and physical limitations, finished pavement containing GTR is still subject to rutting under continuous traffic and/or heavy loads, and also to shoveling in areas of breaking and rapid acceleration.

It is therefore an object of the present invention to provide an improved rubber modified asphalt paving binder that enhances the performance characteristics of asphalt paving composition containing crumb rubber or GTR.

Another object of the invention is to provide an improved process for the manufacture of rubber modified asphalt paving binders.

Summary of the Invention

A first aspect of the present invention provides an asphalt paving binder composition comprising asphalt cement, crumb rubber and polyoctenamer.

A second aspect of the present invention provides a process for the manufacture of such an asphalt paving binder composition.

A third aspect of the present invention provides a paving composition comprising an aggregate material and the above-mentioned asphalt paving binder composition.

A fourth aspect of the present invention provides a process for the manufacture of such a paving composition.

A fifth aspect of the present invention provides a paved surface made of the paving composition.

A sixth aspect of the present invention provides a method of increasing the compatibility of crumb rubber and asphalt cement in an asphalt binder composition.

In accordance with a preferred embodiment of the invention, an improved rubber modified asphalt paving binder is comprised of from about 70% to about 99.5%, more preferably from about 80% to about 99%, further preferably from about 80% to 95%, by weight of asphalt cement, from about 0.5% to about 20%, more preferably from about 2% to about 15%, by weight of crumb rubber, and from about 0.01% to about 10%, more preferably from about 0.2% to about 5%, by weight of a polyoctenamer. It has

been found that the above objects, and other advantages are realized by the incorporation of a relatively minor proportion of a polyoctenamer into the heated liquid asphalt cement. Particularly preferably, the polyoctenamer is added in a dry particulate (or pellets) form to a molten asphalt cement at a temperature of about 325°F (about 163°C) the mixture being stirred or otherwise agitated (as by recirculating pumps) until the polyoctenamer is dissolved and thoroughly mixed. The crumb rubber can be added to the hot asphalt cement with the polyoctenamer pellets or after the polyoctenamer pellets have been dispersed and before or after they have been melted and mixed.

The polyoctenamer is a cyclic macromolecule having a crystalline structure exhibiting a low viscosity above its melting point. The macromolecule has high proportion of double bonds which permits cross-linking and provides a rubbery polymer. Importantly, when the polyoctenamer is melted, it has a viscosity and tackiness comparable to honey. These properties of the melted material assist in the mixing of the GTR in the asphalt cement. Its large number of double bonds allows the polyoctenamer to react with available sites e.g., sulfur of the asphalt constituents, and particularly the asphaltenes and maltenes, while leaving a large number of sites available for reaction with the sulfur at the surface of the GTR (i.e. crumb rubber) that forms the other major component of the binder

composition. Once cooled and cross-linked the polyoctenamer has no tack and reduces the tack of the GTR/asphalt binder so there is little pickup of asphalt from the road surface allowing the road to be rolled much sooner and while it is still hot.

A particularly desirable polyoctenamer is available from Hüls AG of Marl, Germany, and through its distributor in the United States, Creanova Inc. of Somerset, New Jersey, under the trademark VESTENAMER®. The preferred form of the polyoctenamer is trans-polyoctenamer, which is also referred to as "trans-octenamer rubber" (TOR). Two grades of VESTENAMER® trans-polyoctenamer are commercially available: "8012" identifies a material having a trans-content of approximately 80% (and a cis-content of 20%) with a melting point of approximately 54°C; and 6213 having a trans-content of approximately 60% (cis-content of 40%) with a melting point of approximately 30°C. Both of these polymers have a double bond at every eighth carbon atom in the ring. The preferred form of the TOR for use in the practice of the invention has a trans-content of approximately 80%. However, compounds having other ratios of the cis- and trans-isomeric forms of the polyoctenamer (e.g. trans-content of 30-90%) can also be obtained by blending available products for use in the invention. Compounds of this class can be produced in accordance with the teachings of U.S. Patent 3,804,803.

In a preferred embodiment of the invention, the GTR and the polyoctenamer are added to the hot liquified asphalt cement (AC)

that is maintained at a temperature in the range from about 280°F (about 138°C) to about 350°F (about 177°C). The preferred temperature is about 320°F (about 160°C) to about 350°F (about 177°C) and will be dependent upon the qualities and characteristics of the asphalt cement, which as previously explained, can vary with the source.

In a preferred embodiment, the asphalt cement and GTR are maintained at the prescribed temperature range until a homogenous composition is obtained. In many existing field installations, the mixing is so often provided by one or more recirculation pumps in the AC heating tank. In most preferred embodiment of the process, mixing is conducted by low shear rotating blades, paddles or the like which result in a more uniform distribution of the dry and wet materials in the viscous asphalt cement. Mixing may be continued for about 30 minutes to about two to three hours. During the mixing, the polyoctenamer is melted and the double bonds begin to react with the sulfur in the asphalt cement and the sulfur at the surface of the GTR. In view of this surface effect, it is desirable to provide the GTR in a form that has as high as surface area as possible.

After the AC and the GTR or other crumb rubber have been mixed, the dry polyoctenamer is added and the mixing is continued. In the preferred practice of the invention, the GTR is added by dispensing the free-flowing material in the AC while the AC is being circulated and/or otherwise mixed to facilitate

the coating of the GTR particles by the asphalt cement. Thereafter, the polyoctenamer is also added in a dry form and mixing continues while the material dissolves to form a solution with the AC. In this way, the double bonds of the polyoctenamer will react with and cross-link the sulfur and other reactive sites on the surface of the GTR. Thus, as presently understood, the process and composition of the invention provides a superior asphalt binder by enhancing the cross-linking of the asphaltenes, and other reactive sites of the AC with those of the GTR by means of the large number of double bonds available on the polyectonamer, i.e., at every eighth carbon atom.

The preferred form of crumb rubber is ground tire rubber produced by the so-called warm or ambient grinding procedure. The shredding and pulling apart of the tire rubber at ambient temperatures produces irregular particles having a high surface area which desirably increases the number of reactive sites available for bonding or cross-linking with the polyoctenamer. There are many sources of GTR and the material can be used in the vulcanized or a devulcanized form. Devulcanized GTR produced by either an oxidative or reductive process can be used. The graded material having particles sizes that will pass 20 mesh to 480 mesh screens are preferred for practicing the invention. However, any GTR having particle sizes smaller than about 10 mesh can be used.

Various types of grades of GTR are available and have utility in the practice of the invention. For example, conventional automobile passenger tires are formulated by their manufacturers to exhibit certain road handling and comfort characteristics. Truck tires and tires for off-the-road vehicles require different characteristics, and are therefore formulated differently. Another source of crumb rubber suitable for use in the composition is ground industrial waste rubber. These materials can be produced by either ambient grinding or cryogenic grinding. The materials can be mixed to achieve desired properties and to meet specifications.

In order to enhance certain performance specifications, one or more performance enhancing additives can be incorporated in the asphalt binder composition of the invention. It has been found that mineral oil can be added to an asphalt binder of the invention prepared generally in accordance with the above description to maintain the PG value within an acceptable range.

Detailed Description of the Preferred Embodiments

Highway paving compositions employing the improved asphalt paving binder of the invention will be described. In the general practice of the method, an asphalt cement meeting federal highway specification may be added to a heated 10,000 gallon mixing tank at an asphalt terminal or to a recirculating asphalt tanker at the asphalt concrete plant. The asphalt

cement is maintained at a temperature in the range from 280°F (about 138°C) to 350°F (about 177°C) with the average temperature being at the upper end of the range; i.e., 320°F (about 160°C) to 340°F (about 171°C). The asphalt cement is circulated by means of a recirculating pump and/or supplemental mechanical mixing means. In order to facilitate the mixing of the additional ingredients, the heated terminal tank can also be provided with auxiliary agitation in the form of an off-center mounted double propeller or the like. For adding additional ingredients at the asphalt concrete plant, the other ingredients (GTR and polyoctenamer) are added to the Pug mill with the aggregate and asphalt cement which can contain a GTR band.

Generally the mixture of the aggregate material and the asphalt binder composition is mixed until the aggregate material is uniformly coated with the asphalt binder material to form a homogenous asphalt concrete paving composition. Preferably this mixing is conducted in a hopper of a paving spreader machine or a vertical batch production mixer. The aggregate may be any conventional aggregate materials including gravel, crushed rock, stone, quarry gravel and recycled paving material. In certain embodiments, all the steps from the production of the binder composition to the mixing of the binder composition with the aggregate may be conducted at the same location. In other embodiments, the binder composition may be produced at a location remote from a location at which it is mixed with the

aggregate. In the latter case, the binder composition may be transported in a insulated tank. The amount of the binder composition may vary widely depending on a variety of factors and is preferably from about 2 to 30 parts by weight per 100 parts by weight of the resulting paving composition. Other mineral or organic (e.g., ground rubber) materials may further be contained. The amount of the other materials is preferably up to about 20 parts by weight per 100 parts by weight of the resulting paving composition (i.e., asphalt concrete).

The following illustrate typical compositions utilizing representative forms of ground rubber and rubber particles. As will be apparent to one of ordinary skill in the art, the specific proportions and ingredients can be varied to meet local specifications, climatic and other specific conditions.

Example 1

As asphalt paving binder is prepared by heating 91.5 parts of 58-28 asphalt cement to a temperature in the range of 280°F to 320°F and adding, with continuous mixing 8 parts of 80 mesh reground passenger tire rubber (GTR). Mixing is continued for about 2 hours until a uniform blend is obtained. Mixing is continued and 0.5 parts of 80% trans-polyoctenamer (VESTENAMER® 8012) is added with mixing for about 30 minutes until it is dissolved in the asphalt. Thereafter, 6 parts of this asphalt binder is added to 94 parts of a standard stone aggregate in a

conventional or vertical drum batch protection mixer to produce the asphalt concrete. The asphalt concrete is then applied to a suitably prepared sub-surface using standard paving techniques to provide a road surface having improved resistance to rutting and shoveling and to the formation of thin ice sheets.

Example 2

An asphalt paving binder is prepared by heating 80 parts of 58-28 asphalt cement to a temperature in the range of 280°F to 350°F and 18 parts of 40 mesh ground truck tire rubber. Mixing is continued for about 3 hours until a uniform blend is obtained. Mixing is continued and 2 parts of 60% trans-polyoctenamer (VESTENAMER® 6213) is added with mixing for about 30 minutes until it is dissolved in the asphalt. Thereafter, 8 parts of this asphalt binder is mixed with 92 parts of a standard aggregate in the hopper of a paving spreader to produce asphalt concrete which is applied to an appropriately prepared road surface.

Example 3

An asphalt paving binder is prepared by heating 99 parts of 50-30 asphalt cement to a temperature in the range of 280°F to 350°F and 0.9 parts of cryogenically ground industrial waste rubber. Mixing is continued for about 1 hour until a uniform blend is obtained. Thereafter, 0.1 parts of 80% trans-

polyoctenamer (VESTENAMER® 8012) is added with continuous mixing for about 15 minutes until it is dissolved in the asphalt to form the binder. Thereafter, 7 parts or this asphalt binder is mixed with an aggregate blend formed from 90 parts of quarry gravel and 3 parts of recycled glass in a universal mixer to produce asphalt concrete which is then applied in a thickness of about two inches to resurface an appropriately prepared road surface.

Example 4

An asphalt paving binder is prepared by heating 80 parts of 64-18 asphalt cement to a temperature in the range on 280°F to 350°F and adding with continuous mixing 10 parts of ambient ground off-the-road tires. After mixing for about 1.5 hours to obtain a uniform blend, 10 parts of 80% trans-polyoctenamer (VESTENAMER® 8012) is added and mixed for an additional period of about 1.5 hours until it is dissolved in the asphalt to form the binder. Thereafter, 10 parts of this asphalt binder is tadded to a blend of 80 parts gravel and 10 parts of 10 mesh ground tire rubber in a vertical mixer to produce asphalt cement. The resulting asphalt cement is transferred to a truck for transport to the paving site where it is spread on a graded subsurface and rolled to provide a parking lot and access roadways.

Example 5

A highway paving composition is prepared employing the following aggregate mix:

Ingredient	Screen*(inch)	Amount(lbs)
Sand	1/4	2450
#2Gravel	3/8	620
#3Gravel	3/16	950
#4Gravel	1/16	630

* Material will pass a sieve with openings of indicated size

The aggregate, totalling 4650 pounds, is transported from outdoor storage hopper via a flexible conveyor belt system into a heated drum mixer with a horizontal screw that is maintained at a temperature of about 300°F to 400°F to drive off any moisture. The dried aggregate is discharged at a temperature of about 340°-350°F.

The heated aggregate is discharged into a Pug mill having a pair of counter-rotating blades that is oil-heated and maintained at about 300°F. Thereafter, forty pounds of #10 GTR and three(3) pounds of Vestenamer® 8012 trans-polyoctenamer are added to the Pug mill and mixed for about 5-10 seconds at about 90 rpm.

Next, about 350 pounds of a mixture of 7% GTR in asphalt cement at about 340°F is added to the Pug mixer. After mixing for about 30-35 seconds, the asphalt concrete is transferred to a truck for transport to the paving site where it is promptly transferred to the hopper of a paving spreader. The paving composition is advanced from the hopper and further mixed by a 12-inch screw conveyor that moves it forward to the spreader section. A pair of counter-rotating 6-inch screw conveyors uniformly distribute the asphalt concrete along the front section of the spreader where it is deposited on the prepared roadway substrate. The temperature of the paving composition as deposited is about 270°F and about one hour has passed since the initial mixing of the polyoctenamer with the GTR/asphalt cement.

After deposit of the paving composition of the invention, compression with paving rollers was commenced and proceeded for approximately thirty minutes to finish the paving on a section of roadway using this batch of asphalt concrete. The temperature of the compacted road surface during this operation exceeded 150°F. During the rolling operation, it was noted that the surface of the composition of the invention had significantly improved "pick-up" on the rolling equipment as compared to GTR asphalt concrete without the polyoctenamer. The hot asphalt concrete could be rolled much sooner than the prior art composition, which must be allowed to cool down in order to reduce the pick-up of material from the paving surface. It was

also observed that the paving composition was easily discharged from the truck into the paving machine and that the material did not stick to the surfaces of the spreader or lands of the various screw conveyors with which it came into contact.

Based on the evaluation of economic data an asphalt binder composition in accordance with the invention can provide superior performance characteristics at a substantial cost savings, as compared to a binder modified with SBS. These advantages include more uniform mixing of the ingredients, reduction of tack of the rubberized asphalt which reduces road surface pickup (asphalt clinging to the heated roller cylinders), faster paving (the rollers can get onto the hot surface faster) which also gives a better finished composition to the roadway. The invention thus can provide the advantages of a superior road surface for less money, thereby allowing either an increase in the paved miles within the budget authorized, or a savings in the project cost.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. An asphalt paving binder comprised of:

(a) from about 80% to about 99% by weight of asphalt cement;

(b) from about 0.5% to about 20% by weight of crumb rubber, and

(c) from about 0.01% to 10% by weight of polyoctenamer.

2. The asphalt paving binder of claim 1 comprised of:

(a) from about 80% to about 95% by weight of the asphalt cement;

(b) from about 2% to 15% by weight of the crumb rubber; and

(c) from about 0.2% to 5% by weight of the polyoctenamer.

3. The asphalt paving binder of claim 1 or 2, where the polyoctenamer is a trans-polyoctenamer rubber.

4. The asphalt paving binder of claim 3, where the trans-polyoctenamer rubber has a melting point of approximately 54°C.

5. The asphalt paving binder of claim 3 or 4, where the trans-polyoctenamer has approximately 80% of its double bonds in the trans-position.

6. The asphalt paving binder of claim 3, where the trans-polyoctenamer has a melting point of approximately 30°C.

7. The asphalt paving binder of claim 3 or 6, where the trans-polyoctenamer has approximately 60% of its double bonds in the trans-position.

8. The asphalt paving binder of any one of claims 1 to 7, wherein the crumb rubber is produced by a warm ambient grinding procedure and is irregular in appearance when examined by scanning electron microscope (SEM).

9. The asphalt paving binder of any one of claims 1 to 8, wherein the crumb rubber is in a devulcanized form.

10. The asphalt paving binder of any one of claims 1 to 9, wherein the crumb rubber is a graded material having particle sizes that pass 20 mesh to 480 mesh screens.

11. The asphalt paving binder of any one of claims 1 to 10, which has been produced by adding to the crumb rubber and the polyoctenamer to the asphalt cement while the asphalt cement is hot liquified until a uniform mixture is formed.

12. A process for the manufacture of an asphalt paving binder composition comprising:

(a) heating asphalt cement to a temperature in the range from about 280°F (about 138°C) to about 350°F (about 177°C);

(b) adding to the heated asphalt cement from about 0.5 weight percent to about 20 weight percent, based on the total weight of the binder composition, of crumb rubber and from about 0.01 to about 10 weight percent, based on the total weight of the binder composition of polyoctenamer; and

(c) mixing the asphalt cement, crumb rubber and polyoctenamer until the polyoctenamer dissolves to form a homogeneous binder composition.

13. The process of claim 12, where the temperature of the composition is maintained in the range from about 280°F (about 138°C) to about 350°F (about 177°C) during the mixing of step (c).

14. The process of claim 12 or 13, where the mixing of step (c) is continued for from about 30 minutes to about three hours.

15. The process of any one of claims 12 to 14, where the polyoctenamer is dissolved in the heated asphalt cement after the crumb rubber is added.

16. The process of any one of claims 12 to 15, where the polyoctenamer has melting point of about 54°C.

17. The process of any one of claims 12 to 16, where the crumb rubber is ground tire rubber.

18. The process of claim 17, where the ground tire rubber is derived from tires ground at ambient temperatures.

19. The process of claim 17 or 18, where the ground tire rubber has a particle size that will pass 20 mesh to 480 mesh screens.

20. The process of any one of claims 12 to 19, which includes a further step of adding a performance enhancing additive to the binder composition.

21. The process of any one of claims 12 to 20, in which the ingredients are mixed by passing a mixture of them through a recirculating pump.

22. A process for the manufacture of an asphalt concrete paving composition comprising an asphalt binder and aggregate material, the process comprising the steps of:

(a) heating asphalt cement to a temperature in the range from about 280°F (about 138°C) to about 350°F (about 177°C);

(b) adding to the heated asphalt cement from about 0.5 weight percent to about 20 weight percent, based on the total weight of the binder composition, of crumb rubber and from about 0.01 to about 10 weight percent, based on the total weight of the binder, composition, of polyoctenamer;

(c) mixing the asphalt cement, crumb rubber and polyoctenamer until the polyoctenamer dissolves to form a homogeneous binder composition;

(d) combining the aggregate material with the homogeneous binder composition which has been heated; and

(e) mixing the homogeneous heated binder composition and the aggregated material to uniformly coat the aggregate material with the homogeneous heated binder composition to form a homogeneous asphalt concrete paving composition.

23. The process of claim 22, where the mixing of step (e) is part of a substantially continuous process composed of steps (a) to (e).

24. The process of claim 23, where the mixing of step (e) is conducted in a hopper of a paving spreader, machine.

25. The process of claim 24 where the aggregate material comprises recycled paving material.

26. The process of claim 22, where the mixing of step (e) is conducted in a vertical batch production mixer.

27. The process of claim 22, where steps (a)-(c) are performed at a location remote from a location at which steps (d) and (e) are performed, and the process comprises a further step of transporting the homogeneous binder composition prepared by steps (a)-(c) in an insulated tank to the remote location.

28. A paving composition comprising an asphalt binder and mineral aggregate, where the asphalt binder is comprised of asphalt cement, polyoctenamer and crumb rubber.

29. The paving composition of claim 28, where the polyoctenamer is a trans-polyoctenamer having up to about 80% of the double bonds in the trans-position and a melting point of from about 30°C to about 54°C.

30. The paving composition of claim 28 or 29, further comprising graded particles of ground rubber that will pass a 10 mesh screen.

31. The paved composition of any one of claims 28 to 30, wherein the asphalt binder is comprised of from about 80% to about 99% by weight of the asphalt cement, from about 0.5% to about 20% by weight of the crumb rubber and from about 0.01% to about 10% by weight of the polyoctenamer.

32. The paved surface comprising an asphalt binder and mineral aggregate, where the asphalt binder is comprised of asphalt cement, polyoctenamer and crumb rubber.

33. The paved surface of claim 32 where the polyoctenamer is a trans-polyoctenamer having up to about 80% of its double bonds in the trans-position and a melting point of from about 30°C to about 54°C.

34. The paved surface of claim 32 or 33, wherein the asphalt binder, is comprised of from about 80% to about 99% by weight of the asphalt cement, from about 0.5% to about 20% by weight of the crumb rubber and from about 0.01% to about 10% by weight of the polyoctenamer.

35. A method of increasing the compatability of crumb rubber and asphalt cement in an asphalt binder composition, which method comprises adding to the asphalt binder composition,

from about 0.01 to about 10% by weight of polyoctenamer, based on the total weight of the asphalt binder composition.

36. The method of claim 35, where the crumb rubber is ground tire rubber.

37. The method of claim 36, where the ground rubber is comprised of particles that will pass a 40 mesh screen.

38. The method of claim 35, 36 or 37, where the crumb rubber comprises from about 0.5 to about 20 weight percent, based on the weight of the asphalt binder composition.

39. The method of any one of claims 35 to 38, where the polyoctenamer is an isomeric mixture that is about 60-80% trans-polyoctenamer and about 20-40% cis-polyoctenamer.

40. The method of any one of claims 35 to 39, where the polyoctenamer is mixed in melted asphalt cement prior to the addition of the crumb rubber.

41. The method of any one of claims 35 to 40 where the asphalt binder composition is prepared by mixing the asphalt cement, the polyoctenamer and ground tire rubber at a temperature in the range from about 280°F (about 138°C) to about

350°F (about 177°C) for a predetermined time ranging from about 30 minutes to about two hours.

42. The method of claim 41, where the time is sufficient to permit substantial cross-linking between the asphalt cement, the ground tire rubber and the polyoctenamer.

FETHERSTONHAUGH & CO.
OTTAWA, CANADA

PATENT AGENTS