DESCRIPTION

TITLE OF INVENTION: LIGHT-COLORED BINDER COMPOSITION

TECHNICAL FIELD

[0001]

The present invention relates to a colorable light-colored binder composition used for road pavement and the like, and more particularly to a light-colored binder composition suitable for improving weather resistance, workability during construction, and durability while suppressing a tire-adhesion and peeling property.

BACKGROUND ART

[0002]

In road pavement at locations where landscape considerations are important, such as parks and tourist sites, a colorable binder called a light-colored binder is often used instead of a conventional black bituminous binder. The light-colored binder is a substitute material for bituminous binders produced by mixing petroleum resin, rubber, elastomer, heavy petroleum oil, and the like, and since the light-colored binder has a light hue and high transparency, the light-colored binder can be colored using pigments or used to realize road pavement that takes advantage of the texture of aggregates.

[0003]

Such light-colored binders have conventionally been improved in terms of weather resistance and workability during construction. With respect to weather resistance, improvements have been achieved by mixing polymers having high resistance to ultraviolet degradation. With respect to workability during construction, so-called “stringing,” in which the binder adheres to a rake and forms strings when a binder mixture is manually spread using the rake, particularly affects paving operations. Therefore, conventional approaches have sought to improve workability during construction by

suppressing such stringing through selection of an optimum polymer to be mixed into the binder. There has also been proposed a binder composition for light-colored pavement that can avoid the occurrence of stringing during paving by reducing the content of the polymer, while maintaining durability through the addition of ethylene-ethyl acrylate (EEA) (for example, see Patent Document 1).

CITED DOCUMENTS

PATENT LITERATURE

[0004]

Patent Document 1: JP-A-2017-88643

DISCLOSURE OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0005]

Light-colored pavement using such light-colored binders is often applied to locations having relatively low traffic volumes, such as parks and tourist sites. On the other hand, in recent years, the use of light-colored binders has also been increasing for the purpose of improving the visibility of road surfaces inside tunnels and the like. Since such tunnel interiors are subjected to heavy traffic, durability capable of withstanding vehicular traffic is also regarded as important when applying light-colored binders thereto. In order to improve the durability of conventional light-colored binders, one possible approach is to increase the amount of polymer added thereto.

[0006]

However, merely increasing the amount of polymer added to conventional light-colored binders, while improving durability, also increases the occurrence of a

phenomenon as the polymer increases in which a mixture containing the light-colored binder and aggregates adheres to tires, and the pavement adhering to tires is peeled off as the vehicle travels. This is attributable to an increase in affinity of the binder surface for tires resulting from the increased amount of polymer. When such peeling of pavement adhering to tires occurs, the surface of the pavement is worn away and loses its flatness, and early deterioration of the pavement progresses from the damaged portions. Accordingly, improvements have been sought in this regard.

[0007]

Therefore, the present invention has been devised in view of the above-described problems, and an object thereof is to provide a light-colored binder composition capable of improving weather resistance, workability during construction, and durability while suppressing a tire-adhesion and peeling property.

SOLUTIONS TO THE PROBLEMS

[0008]

A light-colored binder composition according to a first invention contains a petroleum-based solvent extracted oil, a petroleum resin, a thermoplastic elastomer: 1.6 weight% or more and 2.8 weight% or less, an ethylene copolymer: 3.5 weight% or more and 6.0 weight% or less, and an FT wax: 0.4 weight% or more and 0.99 weight% or less.

[0009]

In a light-colored binder composition according to a second invention, which is in the first invention, the thermoplastic elastomer is an SEBS having a styrene content rate of 25.0% or more and 35.0% or less, and the ethylene copolymer is any one or both of a methacrylate copolymer and an acrylate copolymer.

[0010]

In a light-colored binder composition according to a third invention, which is in the second invention, the methacrylate copolymer is ethylene-methyl methacrylate (EMMA), and the acrylate copolymer is ethylene-ethyl acrylate (EEA).

[0011]

In a light-colored binder composition according to a fourth invention, which is in the third invention, the EMMA has a methyl methacrylate (MMA) content rate of 10.0% or more and 20.0% or less and a melt mass-flow rate (MFR) of 0.2 g/10 min or more and 1.0 g/10 min or less, and the EEA has an EA content rate of 10.0% or more and 20.0% or less and an MFR of 0.2 g/10 min or more and 1.0 g/10 min or less.

[0012]

In a light-colored binder composition according to a fifth invention, which is in any one of the first invention to the fourth invention, the light-colored binder composition contains an anti-stripping agent.

[0013]

In a light-colored binder composition according to a sixth invention, which is in the fifth invention, the anti-stripping agent is a dimer acid, and a content of the dimer acid is 0.2 weight% or more and 2.0 weight% or less based on a total amount of the composition.

[0014]

An asphalt pavement material according to a seventh invention contains the light-colored binder composition according to any one of the first invention to the sixth invention, and aggregates.

EFFECTS OF THE INVENTION

[0015]

According to the present invention having the above-described configurations, each of the light-colored binder compositions had a penetration (25°C) of 40 (0.1 mm) or more and 70 (0.1 mm) or less, a softening point of 56°C or higher, a viscosity (180°C) of 800 mPa·s or less, a DS as an index for measuring a strength of a road pavement of 1000 passes/mm or more, and adhesion and peeling of 50% or less, and no stringing was observed in any case. Accordingly, it is possible to provide the light-colored binder composition capable of improving weather resistance, workability during construction, and durability while suppressing the tire-adhesion and peeling property.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

Fig. 1 is a diagram for describing a DS measuring method in detail.

Fig. 2 is a diagram illustrating an example of an amount of settlement (mm) with respect to a test time (min) having a start time of DS measurement test as a reference point.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0017]

The following describes a light-colored binder composition according to an embodiment of the present invention in detail.

[0018]

In order to solve the above-described problems, the present inventors invented a light-colored binder composition capable of improving weather resistance, workability during construction, and durability while suppressing the tire-adhesion and peeling property by adding appropriate amounts of SEBS, EMMA or EEA, and FT wax, and

optionally adding an appropriate amount of an anti-stripping agent.

[0019]

The light-colored binder composition according to the present invention contains a petroleum-based solvent extracted oil, a petroleum resin, a thermoplastic elastomer: 1.6 weight% or more and 2.8 weight% or less, an ethylene copolymer: 3.5 weight% or more and 6.0 weight% or less, and an FT wax: 0.4 weight% or more and 0.99 weight% or less.

[0020]

The following describes the component composition of the light-colored binder composition to which the present invention is applied, and the reason for the limitations thereof.

[0021]

Petroleum-Based Solvent Extracted Oil

The petroleum-based solvent extracted oil is an extracted oil produced in a solvent extraction process during the production of lubricating oil from crude oil, and is an oily substance rich in aromatic components and naphthenic components (see "How Petroleum Products Are Made," Fig. 3-1 "General Lubricating Oil Production Process," published by the Petroleum Association of Japan, April 1998, p. 97, and "New Petroleum Dictionary," edited by The Japan Petroleum Institute, 1982, p. 304). The petroleum-based solvent extracted oil is a component that acts as a softening agent when added to the binder composition, and desirably has a boiling point of 350°C or higher, a kinematic viscosity at 60°C of 300 mm^2/s or more and 800 mm^2/s or less, a flash point of 250°C or higher, and an aromatic content of 65% or more.

[0022]

Examples of such petroleum-based solvent extracted oils include solvent extracts of bright stock extracted with solvents such as phenol, N-methylpyrrolidone,

liquid sulfur dioxide, and furfural in a crude oil refining process. From the viewpoint of obtaining favorable handling properties and rutting resistance, the content of the petroleum-based solvent extracted oil is desirably 40 weight% or more and 80 weight% or less, 45 weight% or more and 75 weight% or less, or 50 weight% or more and 70 weight% or less, based on the total weight of the light-colored binder composition. By setting the content of the petroleum-based solvent extracted oil within the above-described range, the binder can avoid becoming excessively soft, thereby improving fluidity resistance (rutting resistance). The viscosity of the binder can also avoid becoming excessively high, thereby making the binder suitable in terms of workability during construction as well.

[0023]

Petroleum Resin

The petroleum resin is a polymerized product of cracking by-products generated during the production of ethylene, propylene, and the like by thermal cracking of naphtha, and those having high contents of cyclopentadiene (CPD) and dicyclopentadiene (DCPD) have high softening points. The petroleum resin is a colorless to pale yellow resin having a molecular weight of about 200 or more and 2000 or less, generally 1000 or more and 1500 or less, and a softening point of 100°C or higher and 150°C or lower. From the viewpoint of obtaining favorable handling properties, the petroleum resin is desirably 10 weight% or more and 50 weight% or less, 15 weight% or more and 45 weight% or less, and further 20 weight% or more and 40 weight% or less.

[0024]

By setting the content of the petroleum resin within the above-described range, the viscosity can be optimized to further improve workability during construction and to further avoid a decrease in fluidity resistance.

[0025]

Thermoplastic Elastomer: 1.6 weight% or more and 2.8 weight% or less

The content of thermoplastic elastomer is set to 2 weight% or more and 2.8 weight% or less based on the total weight of the light-colored binder composition. When the content of thermoplastic elastomer is more than 2.8 weight%, so-called stringing occurs during handling of the light-colored binder when the temperature thereof falls below about 120°C to 130°C. The stringing refers to a state in which the viscosity of the binder becomes high such that the binder assumes a so-called viscous form, and, upon contact therewith, the viscous material is stretched into thread-like strands. Further, when the content of thermoplastic elastomer is more than 2.8 weight%, the affinity of the binder surface for tires increases, resulting in deterioration of the adhesion and peeling property. Therefore, in the present invention, the content of thermoplastic elastomer is set to 2.8 weight% or less, thereby suppressing the occurrence of stringing during the work and avoiding a significant decrease in workability during construction. When the content of thermoplastic elastomer is less than 1.6 weight%, the effect of avoiding brittle fracture due to hardening cannot be obtained, and the DS (Dynamic Stability) decreases.

[0026]

Therefore, the content of thermoplastic elastomer is, based on the total weight of the light-colored binder composition, 1.6 weight% or more and 2.8 weight% or less, more preferably 2.0 weight% or more and 2.8 weight% or less, still more preferably 2.3 weight% or more and 2.7 weight% or less, and particularly preferably 2.4 weight% or more and 2.6 weight% or less.

[0027]

In the present invention, any thermoplastic elastomer may be added, and

particularly, it is desired to add SEBS. SEBS is obtained by eliminating double bonds through complete hydrogenation treatment of the butadiene blocks in a styrene-butadiene-styrene block copolymer (SBS), thereby significantly improving heat resistance and weather resistance as compared with SBS. However, since the hydrogenation treatment changes the flexibility of the molecular chains, the effects produced when added to a bituminous binder composition also differ from those of SBS.

[0028]

SEBS preferably has a styrene content rate within a range of 25% or more and 35% or less. Preferably, the styrene content rate is 28% or more and 33% or less.

[0029]

Since the SEBS having the above-described physical properties can be configured to have excellent elasticity, by adding the SEBS to the light-colored binder composition according to the present invention, both improvement of DS, which is an index for measuring the strength of a road pavement, and avoiding brittle fracture due to hardening can be achieved simultaneously.

[0030]

Ethylene Copolymer: 3.5 weight% or more and 6.0 weight% or less

The content of ethylene copolymer is set to 3.5 weight% or more and 6.0 weight% or less based on the total weight of the light-colored binder composition. When the content of ethylene copolymer is less than 3.5 weight%, DS decreases, the adhesion and peeling property deteriorates, and stringing occurs during the work. When the content of ethylene copolymer is more than 6.0 weight%, the adhesion and peeling property deteriorates.

[0031]

In the present invention, the ethylene copolymer may be any one or both of a

methacrylate copolymer and an acrylate copolymer. As the methacrylate copolymer, ethylene-methyl methacrylate (EMMA) may be used, and as the acrylate copolymer, ethylene-ethyl acrylate (EEA) may be used.

[0032]

For example, while any ethylene copolymer may be added, such as ethylene-acrylic acid resin (EAA) and modified ethylene-vinyl acetate copolymer (modified EVA), among them, it is desirable to add one or both of EMMA and EEA.

[0033]

EMMA is a thermoplastic resin that is a copolymer of ethylene and methyl methacrylate, and is a resin having high flexibility and transparency. By using EMMA having a methyl methacrylate (MMA) content rate of 10% or more and 20% or less and a melt mass-flow rate (MFR) of 0.2 g/10 min or more and 1.0 g/10 min or less, it is possible to suppress a decrease in the flexibility of the binder composition accompanying an increase in viscosity, suppress an increase in viscosity, and avoid a decrease in DS. By setting the content of EMMA to 3.5 weight% or more and 6.0 weight% or less based on the total weight of the light-colored binder composition, the DS can be improved, the deterioration of the adhesion and peeling property can be avoided, and the occurrence of stringing during the work can be avoided.

[0034]

EMMA may be replaced with ethylene-ethyl acrylate (EEA). Similarly to EMMA, EEA is also limited in terms of EA content rate and MFR. EEA used as a substitute for EMMA has the EA content rate of 10% or more and 20% or less and the MFR of 0.2 g/10 min or more and 1.0 g/10 min or less. By setting the content of EEA to 3.5 weight% or more and 6.0 weight% or less based on the total weight of the light-colored binder composition, the DS can be improved, the deterioration of the adhesion

and peeling property can be avoided, and the occurrence of stringing during the work can be avoided.

[0035]

While the content rates of EMMA and EEA are desirably set within the range of 3.5 weight% or more and 6.0 weight% or less, in order to achieve the above-described effects, the content rates of EMMA and EEA may be more preferably 3.5 weight% or more and 5.0 weight% or less, and still more preferably 4.0 weight% or more and 4.5 weight% or less.

[0036]

FT Wax: 0.4 weight% or more and 0.99 weight% or less

The FT wax is a wax composed of long-chain linear hydrocarbons produced by the Fischer-Tropsch process. This wax is solid at normal temperature and pressure, and has a high melting point and low viscosity. That is, the viscosity of FT wax is clearly lower than that of general waxes. In addition, the FT wax has high heat resistance and abrasion resistance, and is also excellent in waterproofness and protective properties. The FT wax preferably has the melting point of 100°C or higher. Using FT wax having a low melting point may affect the properties of the binder. In the present invention, the FT wax serves to improve the adhesion and peeling property by localizing at the binder surface and reducing the adhesiveness between the binder and rubber tires. Although other waxes such as paraffin wax and polyethylene-based wax are also available, the FT wax is preferred in view of compatibility.

[0037]

The content of FT wax is set to 0.4 weight% or more and 0.99 weight% or less based on the total weight of the binder composition. When the content of FT wax is less than 0.4 weight%, the above-described effect of reducing the adhesiveness between the

binder and rubber tires cannot be obtained, thus deteriorating the adhesion and peeling property. When the content of FT wax exceeds 0.99 weight%, there is no correlation between toughness in the low-temperature range and a decrease in DS, and excessive addition of the wax makes it impossible to maintain the uniformity of the binder components, thereby causing the decrease in DS.

[0038]

Anti-Stripping Agent

In the present invention, it is preferable to add an anti-stripping agent to avoid separation between the light-colored binder composition and the aggregates. Dimer acid can be suitably used as the anti-stripping agent, and the dimer acid is produced by polymerization of C18 unsaturated fatty acids derived from vegetable oils and fats. By also including the dimer acid in the binder composition, the dimer acid acts to avoid separation from the aggregates when mixed with the aggregates. While the dimer acid is used as a preferred anti-stripping agent in the present invention, the anti-stripping agent is not limited thereto.

[0039]

As the anti-stripping agent, a resin acid may be used in addition to the dimer acid.

[0040]

A resin acid is rosin containing one or more of abietic acid, dehydroabietic acid, neoabietic acid, pimaric acid, isopimaric acid, and palustric acid, each of which is a polycyclic diterpene having 20 carbon atoms and a carboxyl group.

[0041]

Here, gum rosin, wood rosin, tall oil rosin, and the like are used as the rosin. These rosins can be classified into the above-described gum rosin, wood rosin, and the like depending on differences in origin, raw materials, and collection methods, but are at

least obtained as residual components from steam distillation of pine resin. The rosin is a mixture containing, as components, abietic acid, palustric acid, neoabietic acid, dehydroabietic acid, pimaric acid, sandaracopimaric acid, isopimaric acid, and the like. The rosin generally softens at about 80°C and melts at 90°C or higher and 100°C or lower. While rosin contains various resin acids such as abietic acid, dehydroabietic acid, dihydroabietic acid, tetrahydroabietic acid, palustric acid, neoabietic acid, and levopimaric acid, these resin acids may each be purified and used individually.

[0042]

In the present invention, addition of the anti-stripping agent is not indispensable, and the content thereof may be 0.0 weight% based on the total weight of the light-colored binder composition. However, when the anti-stripping agent is added, the content thereof is desirably 0.2 weight% or more and 2.0 weight% or less based on the total weight of the light-colored binder composition. When the content of the anti-stripping agent is set to 0.2 weight% or more, separation occurring when mixed with the aggregates can be avoided, thereby further improving the stability of the binder composition as a final product. In contrast, when the content of the anti-stripping agent exceeds 2.0 weight%, not only does the effect of improving stability become saturated, but also a problem arises in that the raw material cost increases significantly due to the increased amount of the expensive anti-stripping agent added. That is, even when the anti-stripping agent is added in an amount exceeding 2.0 weight%, stability is not further significantly improved, and rather this becomes disadvantageous in terms of raw material cost.

[0043]

The anti-stripping agent is desirably contained in a range of 0.2 weight% or more and 1.0 weight% or less based on the total weight of the binder composition. By setting

the upper limit of the content of the anti-stripping agent to 1.0 weight%, it is possible to improve the stability of the binder composition while suppressing an increase in raw material cost as much as possible, thereby improving cost effectiveness.

[0044]

The anti-stripping agent is contained in a range of more preferably 0.3 weight% or more and 0.9 weight% or less, and still preferably 0.4 weight% or more and 0.6 weight% or less, based on the total weight of the binder composition.

[0045]

An asphalt pavement material containing the light-colored binder composition having the above-described configurations and aggregates is formed. Among the mixture types presented in Pavement Design and Construction Guidelines, it is known that the content rate of the light-colored binder is 3.5 weight% or more and 9.0 weight% or less based on the total amount of the asphalt pavement material. Accordingly, in the present invention, the content rate of the light-colored binder may be 3.5 weight% or more and 9.0 weight% or less based on the total amount of the asphalt pavement material, but is not limited to the range.

[Example 1]

[0046]

The following describes embodiments specifically with reference to test methods, examples, and comparative examples used in the present invention. However, the present invention is not limited to these examples. In the following examples, a notation with % alone indicates weight%.

[0047]

In the present invention, samples of Examples and Comparative Examples were prepared for experimental evaluation. The samples were prepared by adding a

predetermined amount of the above-described SEBS to the petroleum-based solvent extracted oil in a molten state at a temperature of about 180°C, and further adding the above-described petroleum resin, EMMA or EEA, FT wax, and dimer acid so as to achieve the above-described blending ratios. Mixing was carried out using a homomixer or a propeller mixer at a rotational speed of 2000 rpm or more and 3500 rpm or less for about 3 to 4 hours while mixing and stirring. The temperature of the binder composition at the completion of mixing was adjusted to 190°C or higher and 200°C or lower.

[0048]

For each of the obtained samples of Examples and Comparative Examples, performance tests including penetration (25°C), softening point, viscosity (180°C), DS, degree of adhesion and peeling during WT (Wheel Tracking) test, and occurrence or non-occurrence of stringing were conducted, as shown in Table 1. Detailed test methods will be described below.

[0049]

[Table 1]

Composition	Unit	Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Example 7	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4	Comparative Example 5	Comparative Example 6	Comparative Example 7	Comparative Example 8	Comparative Example 9	Comparative Example 10	Comparative Example 11
Petroleum-based solvent extracted oil	Wt%	59.7	59.7	58.1	58.2	59.2	59.1	59.4	59.5	59.6	58.5	59.7	59.2	56.5	58.0	59.1	59.0	59.1	59.0
Petroleum resin		32.3	32.8	33.9	32.8	32.8	33.9	32.6	34.0	33.4	32.5	33.2	32.8	36.5	35.0	32.4	34.5	33.9	31.0
SEBS		2.5	2.5	2.5	2.0	2.5	2.5	2.5	2.0	2.5	2.5	2.5	2.5	1.5	2.5	3.0	2.0	2.5	2.0
EMMA		4.0	4.0	4.0	5.5			2.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	4.0			
EEA						4.0	4.0	2.0									4.0	4.0	6.5
FT wax 1		0.99	0.5		0.99	0.99	0.5	0.99			2.0	0.1		0.99	0.99	0.99			0.99
FT wax 2				0.99															
Paraffin wax													0.99						
Dimer acid		0.5	0.5	0.5	0.5	0.5		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Total		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Properties																			
Penetration (25°C)	1/10 mm	47	45	47	46	46	48	48	44	45	48	43	48	40	45	47	47	45	47
Softening point	°C	82.0	84.5	82.5	83.0	92.0	82.0	82.5	81.0	81.0	81.0	82.0	82.0	83.0	83.0	83.5	83.0	86.5	83.0
Viscosity@180°C	mPa·s	340	372	356	345	295	340	312	264	350	317	356	331	241	262	412	232	317	520
DS	passes/mm	1167	1167	1800	1340	1800	1500	1650	969	1016	788	955	788	900	741	1650	984	2250	1800
Adhesion and peeling		35%	35%	25%	40%	50%	35%	30%	80%	95%	45%	80%	55%	30%	55%	55%	55%	85%	60%
Stringing		Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Absent	Absent	Present	Present	Present

[0050]

The penetration (25°C) was measured in accordance with JIS K 2207 “Petroleum Bitumen-Test Method for Penetration.” This value is preferably 40 (0.1 mm) or more and 70 (0.1 mm) or less.

[0051]

The softening point was measured in accordance with JIS K 2207 “Petroleum Bitumen-Test Method for Softening Point.” This value is preferably 56 (°C) or higher.

[0052]

The viscosity (180°C) was measured under the conditions specified in JPI-5S-54-99 “Asphalts-Determination of viscosity with a rotational viscometer,” at a measurement temperature of 180°C using spindle SC4-21 at a spindle rotational speed of 20 rpm.

[0053]

The viscosity (180°C) is related to the hardness of the bitumen mixture during the work, and when the viscosity becomes high, workability during construction deteriorates, making it impossible to produce a predetermined pavement. Therefore, the viscosity is preferably 800 mPa·s or less.

[0054]

The strength of the bituminous binder composition is evaluated based on DS in accordance with “B003 Wheel Tracking Test Method” described in Handbook of Pavement Survey and Test Methods (edited by Japan Road Association). The DS is used exclusively as an index for measuring the strength of a road pavement. However, even when the binder composition is applied to uses such as waterproofing materials and adhesive materials, improvement in strength may likewise be required, and accordingly it is sufficiently conceivable to evaluate the strength through the DS. Therefore, while

the DS is used as an evaluation index in the present invention, the binder composition may be applied not only to road pavement but also to any applications including waterproofing materials and adhesive materials.

[0055]

The following describes a method for measuring the DS. The DS is an index for evaluating the fluidity resistance (resistance to rutting) of the binder composition at high temperatures, and is measured using a wheel tracking tester. The wheel tracking test is performed at 60°C, assuming road surface conditions in summer. A sample specimen obtained by mixing the binder composition with aggregates adjusted to a predetermined particle size distribution shown in Table 2 described later is cured at 60°C for 5 hours or more, and a wheel is then caused to travel thereon for 1 hour. In Examples and Comparative Examples, for example, as illustrated in Fig. 1, a sample specimen 5 having dimensions of 30 × 30 × 5 cm was cured.

[0056]

[Table 2]

Sieve	Passing mass percentage (%)	Desired particle size range
19.0 mm	100	100
13.2 mm	98.5	95–99
4.75 mm	63.8	61–65
2.36 mm	42.8	40–44
0.6 mm	23.7	21–25
0.3 mm	16.1	16–20
0.15 mm	7.8	5–9
0.075 mm	5.2	2–6

[0057]

Next, a wheel 11 is caused to reciprocate on the sample specimen 5 in the direction indicated by the arrow in the drawing at a rate of 42 passes per minute while

applying a downward load of 686 N by the wheel 11. Incidentally, the traveling position of the wheel 11 is maintained on the same traveling path without deviation.

[0058]

Fig. 2 illustrates an example of an amount of settlement (mm) with respect to a test time (min) having a start time of DS measurement test as a reference point. As the test time increases from the start time of the test, the amount of settlement caused by the reciprocating travel of the wheel 11 increases. This amount of settlement is the settlement depth (mm) from the surface of the sample specimen 5 in the depth direction.

[0059]

In the measurement of DS, the amount of settlement occurring before 45 minutes have elapsed from the initial start time of the test is not taken into consideration. The reason for this is that, before 45 minutes have elapsed from the initial start time of the test, the amount of settlement is determined by factors such as interlocking with the added aggregates, making it impossible to evaluate fluidity resistance in its true sense.

[0060]

In the measurement of DS, attention is focused on the deformation amount ***d*** (mm) of the bituminous binder mixture during the 15-minute period from 45 minutes after the start of the test to 60 minutes after the start of the test, surely taking the test start time as the reference point. The ***d*** can be calculated by determining the difference between the amount of settlement at 60 minutes after the start of the test as the reference point and the amount of settlement at 45 minutes after the start of the test as the reference point. The DS can be obtained from Equation (2) below.

[0061]

DS (passes/mm) = number of tire passes from 45 minutes elapsed to 60 minutes elapsed (passes)/d (mm) …… (2)

The DS can be obtained from the equation. When the frequency of reciprocation of the wheel 11 is 42 (passes/min), Equation (2) can be transformed into the following Equation (2)′.

[0062]

DS (passes/mm) = 630 (passes)/d (mm) …… (2)′

[0063]

The numerator in Equation (2)′ means 42 (passes/min) × 15 (min) = 630 (passes). That is, the DS can be determined from the number of tire passes during a 15-minute period relative to ***d*** (mm). The higher the DS, the smaller the deformation amount of the binder mixture itself, meaning that the material has higher resistance to rutting and higher strength.

[0064]

The DS is measured not by testing the binder composition alone, but by using a molded sample specimen prepared by mixing the binder composition with aggregates (such as crushed stone, sand, and stone powder (limestone)) adjusted to the particle size distribution shown in Table 2 under predetermined conditions described later, as in actual road pavement. In the present Examples, mixing was carried out such that the content of the binder composition was 5.7 weight% based on the total amount of the asphalt pavement material (sample specimen).

[0065]

The higher the DS, the higher the strength of the bitumen, meaning that a pavement material having higher resistance to rutting can be provided. In the present invention, the desired DS is 1000 passes/mm or more.

[0066]

A specific method for preparing the sample specimen for measuring the DS using

the binder composition of the present invention is described below.

[0067]

As the aggregates, crushed stone composed of hard sandstone is used, and for adjustment of the fine aggregates fraction (constituent components having small particle diameters), crushed sand obtained by crushing hard sandstone, sea sand, and stone powder obtained by pulverizing limestone are used to prepare the sample specimen.

[0068]

The stone powder obtained by pulverizing limestone and used for adjusting the particle size distribution of the aggregates is one that conforms to JIS A 5008 “Limestone Powder for Pavement,” and has a passing mass percentage through a 600 μm sieve of 100%, a passing mass percentage through a 150 μm sieve of 90% or more and 100% or less, or a passing mass percentage through a 75 μm sieve of 70% or more and 100% or less, and a moisture content of 1% or less.

[0069]

As the aggregates other than the stone powder, crushed stone composed of hard sandstone is used, and aggregates satisfying the properties indicated in the following (1) to (6) are used.

[0070]

(1) Water absorption: less than 1.5%, desirably less than 1.0% (JIS A 1110)

Here, crushed stone having a water absorption of 0.64% was used. When the water absorption of the aggregates is high, the coated bituminous binder is absorbed by the aggregates, resulting in a composition in which the amount of bituminous binder in the mixture is reduced. In addition, in aggregates having high water absorption, the amount of bituminous binder absorbed greatly varies depending on the humidity during use and the wet condition of the surface, resulting in fluctuations in the amount of

bituminous binder in the mixture. Therefore, in order to maintain a constant amount of bituminous binder in the mixture, the water absorption needs to be less than 1.5%, desirably less than 1.0%.

[0071]

(2) Apparent density: 2.60 g/cm^3 or more and 2.70 g/cm^3 or less (JIS A 1110)

Here, crushed stone having an apparent density of 2.66 g/cm^3 was used.

[0072]

(3) Stability: 6% or less, desirably 3% or less (JIS A 1122)

Here, crushed stone having a stability of 2.4% was used. The stability herein refers to stability against freezing and thawing. The smaller the value of the stability, the less destruction of the aggregates during freezing and thawing. Although Pavement Design and Construction Guidelines specify a value of 12% or less, in order to suppress variations in aggregates properties, the value is set to half of that specified in the Guidelines.

[0073]

(4) Abrasion Loss: 20% or less, desirably 15% or less (JIS A 1121)

Here, crushed stone having an abrasion loss of 12.6% was used. The abrasion loss test is a test for evaluating the hardness of the aggregates and resistance to abrasion, namely, the durability of the aggregates. Since rutting increases when the abrasion loss exceeds 20%, the abrasion loss was set to 20% or less, desirably 15% or less.

[0074]

(5) Soft stone content: 5.0% or less, desirably 3.0% or less (JIS A 1126)

Here, crushed stone having a soft stone content of 2.5% was used. The soft stone content is determined by a test in which it is judged whether scratch marks are formed by a brass rod (Mohs hardness: 3 to 4), thereby determining whether the

aggregates are harder or softer than brass. Similarly to the abrasion loss test, the soft stone content is a test for evaluating the hardness of the aggregates and resistance to abrasion, namely, the durability of the aggregates. The soft stone content generally needs to be 5% or less (see Handbook of Pavement Survey and Test Methods, A008).

[0075]

(6) Content of elongated or flat stone fragments: 10.0% or less, desirably 5.0% or less (Pavement Design and Construction Guidelines (Specified Values) and Handbook of Pavement Survey and Test Methods, A008 (Test Methods))

Here, crushed stone having a content of elongated or flat stone fragments of 2.8% was used. The stone fragments referred to herein are generally elongated or flat stone fragments having a major axis/minor axis ratio of 3 or more. When elongated or flat stone fragments are mixed in, the pavement or the sample specimen may become more susceptible to deformation under a load applied from a certain direction. That is, when a large amount of elongated or flat stone fragments is mixed in, the fragments tend to become aligned in the same direction, making them more susceptible to deformation under a load parallel to that direction than under a load perpendicular thereto.

[0076]

Therefore, in the measurement of rutting resistance performance (DS), the obtained values will vary greatly unless the amount of elongated or flat stone fragments mixed in is limited.

[0077]

Using crushed stone and stone powder satisfying these properties as aggregates, the aggregates blending shown in Table 2 was adjusted, and sample specimens were prepared under the conditions shown in Table 3.

[0078]

Actual preparation of the sample specimens generally includes two stages: mixing of the binder composition and the aggregates, and rolling compaction. For the mixing, 608 g of the binder composition heated to 175°C and 10065 g of the aggregates heated to 175°C and blended to the above-described particle size distribution (hereinafter, the adjusted particle size distribution is referred to as a combined particle size distribution) are prepared.

[0079]

First, the aggregates were placed in a mixer, and the aggregates alone were mixed for 60 seconds to achieve uniformity. The mixing was then temporarily stopped, and after 608 g of the binder composition was charged into the mixer, the binder composition and the aggregates were mixed for 120 seconds.

[0080]

After completion of the mixing, the binder composition and the aggregates were placed into a wheel tracking test mold (inside dimensions: 30.0 cm length, 30.0 cm width, and 5.0 cm depth) and subjected to rolling compaction.

[0081]

For the rolling compaction, rolling compaction is applied to the mixed binder by rolling a cylindrical roller having a radius of 460 mm under the rolling compaction temperature shown in Table 3 below. The rolling compaction is carried out in two stages, namely, primary rolling compaction and secondary rolling compaction. Thereafter, drying is performed for 8 hours.

[0082]

[Table 3]

Mixing conditions of binder composition and aggregates	
Device used for mixing	**TA-381 (30 kg mixing mixer), manufactured by Freesia Macross Corporation**
Binder composition amount	**608 g**
Binder composition temperature	**175°C**
Amount of aggregates adjusted to particle size distribution of mixture	**10065 g**
Temperature of aggregates adjusted to particle size distribution of mixture	**175°C**
Mixing time of binder composition and aggregates	**120 seconds**
Sample specimen porosity	**4.10%**
Degree of compaction	**100%**
Rolling compaction conditions	
Rolling compaction temperature	**165°C**
Shape of rolling compaction roller	**Cylindrical roller, radius: 460 mm**
Primary rolling compaction pressure, number of passes	**0.4 MPa, 24 passes (12 reciprocations)**
Secondary rolling compaction pressure, number of passes	**0.75 MPa, 24 passes (12 reciprocations)**

[0083]

The following describes a method for measuring the degree of adhesion and peeling during WT test. Since light-colored binders have higher affinity for rubber tires than ordinary black bitumen, a phenomenon is likely to occur in which a mixture containing the light-colored binder and aggregates adheres to the tires, and the pavement adhering to the tires is peeled off as the vehicle travels. In order to evaluate performance with respect to resistance to this phenomenon, the sample specimens subjected to the WT test for DS measurement were evaluated for the degree of stripping of the bituminous binder on the surface of the pavement in the rut portion traveled by the tires in the WT test. The specific evaluation method is described below. Attention is focused on the rut portion of the sample specimen after the WT test, and the stripping condition of the binder on the surface thereof is transcribed onto graph paper. Then, the proportion (%) of portions where the binder on the surface has been stripped off relative to the entire area of the rut portion is roughly estimated from the area on the graph paper. When it is

difficult to determine whether stripping has occurred, the surface of the pavement is illuminated with light in a dark place, and the determination is made based on the degree of light reflection. Since the surface of the pavement is worn away and loses its flatness when the degree of adhesion and peeling is high, the degree of adhesion and peeling is desirably 50% or less.

[0084]

Since no particular test for the occurrence of stringing is specified in JIS or the like, the bituminous binder composition samples obtained in Examples and Comparative Examples were heated to about 130°C, and after wearing work gloves on both hands, preferably in a double layer, about 3 to 5 g of the sample was placed on the palm of the left or right hand, and the palms were brought into contact with each other. Thereafter, the hands were gradually separated by 5 cm or more, and visual observation was performed to confirm whether stringing occurred. As a result, when one or more strings were observed, the result was rated as “Poor” indicating that stringing had occurred, and when no strings were observed, the result was rated as “Good” indicating that no stringing had occurred.

[0085]

The following describes Examples and Comparative Examples in detail.

[0086]

The petroleum-based solvent extracted oil used in the verification has representative properties including a kinematic viscosity at 60°C of 512 mm^2/s, a flash point of 338°C, and an aromatic content of 65.9%.

[0087]

The petroleum resin used in the verification has representative properties including a softening point of 140°C, an acid value of 0.1 mgKOH as specified in JIS K

0070, a bromine value of 25 g as specified in JIS K 2543, and a polyethylene-equivalent number-average molecular weight of about 1000 measured by the GPC (Gel Permeation Chromatography) method.

[0088]

The SEBS used in the verification has a viscosity of a 10% toluene solution at 25°C of 1800 mPa·s and a styrene content rate of 30%.

[0089]

The MMA used in the verification has an MFR of 0.25 g/10 min and an MMA blending ratio of 17 weight%.

[0090]

The EEA used in the verification has an MFR of 0.5 g/10 min and an EA blending ratio of 16 weight%.

[0091]

The FT wax 1 used in the verification has a viscosity at 140°C of 20 cP, a solidification point of 99°C (measurement method: D938), and a softening point of 110°C (measurement method: ASTM D3954).

[0092]

The FT wax 2 has a viscosity at 140°C of 12.5 cP and a melting point (JIS K 2235.5.3.1).

[0093]

The measuring methods for viscosity were all conducted in accordance with JPI-5S-54-99 (Asphalts-Determination of viscosity with a rotational viscometer).

[0094]

The paraffin wax having a melting point of 82°C±2°C was used.

[0095]

As the anti-stripping agent used in the verification, a dimer acid (tall oil fatty acid dimer having 36 carbon atoms and an acid value of 190 or more and 210 or less) was used in order to exhibit anti-stripping properties and compatibilizing properties with the aggregates.

[0096]

The content ratios of the components of Examples 1 to 7 all fall within the ranges specified above in the present invention. Each of Examples 1 to 7 satisfied the criteria for the evaluation items described above. That is, each of the light-colored binder compositions according to Examples 1 to 7 had a penetration (25°C) of 40 (0.1 mm) or more and 70 (0.1 mm) or less, a softening point of 56°C or higher, a viscosity (180°C) of 800 mPa·s or less, a DS of 1000 passes/mm or more, and adhesion and peeling of 50% or less, and no stringing was observed in any case, resulting in a rating of "Good." Accordingly, it is seen that, by using the components within the ranges specified in the present invention, weather resistance, workability during construction, and durability can be improved while suppressing the tire-adhesion and peeling property.

DESCRIPTION OF REFERENCE SIGNS

[0097]

5: Sample specimen

11: Wheel

CLAIMS

[Claim 1] A light-colored binder composition comprising:

a petroleum-based solvent extracted oil;

a petroleum resin;

a thermoplastic elastomer: 1.6 weight% or more and 2.8 weight% or less;

an ethylene copolymer: 3.5 weight% or more and 6.0 weight% or less; and

an FT wax: 0.4 weight% or more and 0.99 weight% or less.

[Claim 2] The light-colored binder composition according to claim 1, wherein

the thermoplastic elastomer is an SEBS having a styrene content rate of 25.0% or more and 35.0% or less, and

the ethylene copolymer is any one or both of a methacrylate copolymer and an acrylate copolymer.

[Claim 3] The light-colored binder composition according to claim 2, wherein

the methacrylate copolymer is ethylene-methyl methacrylate (EMMA), and

the acrylate copolymer is ethylene-ethyl acrylate (EEA).

[Claim 4] The light-colored binder composition according to claim 3, wherein

the EMMA has a methyl methacrylate (MMA) content rate of 10.0% or more and 20.0% or less and a melt mass-flow rate (MFR) of 0.2 g/10 min or more and 1.0 g/10 min or less, and

the EEA has an EA content rate of 10.0% or more and 20.0% or less and an MFR of 0.2 g/10 min or more and 1.0 g/10 min or less.

[Claim 5] The light-colored binder composition according to any one of claims 1 to 4, wherein

the light-colored binder composition contains an anti-stripping agent.

[Claim 6] The light-colored binder composition according to claim 5, wherein

the anti-stripping agent is a dimer acid, and a content of the dimer acid is 0.2 weight% or more and 2.0 weight% or less based on a total amount of the composition.

[Claim 7] An asphalt pavement material comprising:

the light-colored binder composition according to any one of claims 1 to 6; and

aggregates.