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RESEARCH OF PROCESSING PRODUCTS OF RUBBER-CONTAINING WASTE IN THE PRODUCTION OF BITUMINOUS BUILDING MATERIALS

***Abstract**: In this work, studies were carried out on the introduction of crumb rubber (RC) into road bitumen and bitumen-mineral mixtures and it was determined that for the modification of petroleum bitumen it is necessary to use only the tread part of a tire with a crumb size of 0.8-2 mm. The optimal amount of RC additive in bitumen is 4 -5%. In this case, the decrease in the penetration depth of the needle (penetration) at 25 ° C does not exceed 19% for BND bitumen 60/90, and 28% for Baki80 / 25 bitumen, while the extensibility decreases, respectively, from 98 to 17 0.1 mm and from 100 to 26 * 0.1 mm.*

***Key words**: Bitumen, modification, penetration, rubber crumb, polymer, physical and mechanical parameters, softening temperature, swelling, frost resistance.*
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Introduction

Problem and its relevance. Over time, during storage and under operating conditions, under the influence of sunlight and air oxygen, the composition and properties of bitumen change: the relative content of solid and brittle components increases in them and, accordingly, the amount of oily and resinous fractions decreases, in connection with which fragility and hardness increase (aging process) [1-5] .. Petroleum bitumens are widely used in road and civil construction, due to their high plasticity, the ability to withstand the effects of low temperatures, temperature changes, various deformation loads without destruction [9-10]. The main consumer of petroleum bitumen is road construction, currently up to 90% of the volume of commercial bitumen produced worldwide is consumed by the road industry.

It is possible to improve the properties of bitumen by combining them with polymer additives

The use of crumb rubber with a particle size of 2-8 mm in asphalt concrete mixtures led to a decrease in the service life of asphalt concrete pavements due to the "impossibility of forming a homogeneous material capable of taking loads", although at the same time in the initial period of operation of such coatings (immediately after laying) increased crack resistance and high deformability, water resistance, reduced noise and vibration levels, reduced cases of ice crust formation, increased adhesion, reduced vehicle braking distance [6-8].

Polymer bitumen materials can be considered as composites in which bitumen plays the role of a matrix, and a polymer is the dispersed phase. At low polymer concentrations, the compositions can be considered as dispersion-strengthened. In this case, hardening occurs due to the fact that fine dispersed particles prevent the propagation of cracks in the matrix. This effect is observed when the content of the dispersed phase is 2-4% by volume. At a higher concentration of polymer in bitumen, the compositions can be considered as fibrous or resinous. The matrix turns into a medium that transfers the load to the fibers, and in the event of their destruction, redistributes the stresses. Such compositions are characterized by increased strength, elasticity and resistance to fatigue fracture, which is especially necessary to ensure the operational reliability of the material, for example, polymer-bitumen compositions modified with butyl rubber and polyethylene [8-11].

Experimental and Discussion
Materials

Due to the improved characteristics of the binder, especially adhesion, the service life of asphalt concrete pavements prepared using RBK binder is at least twice as long as the service life of coatings using traditional bitumen under the same operating conditions due to the higher crack resistance, water resistance, shear resistance of the resulting asphalt concrete. Such coatings can reduce the level of noise and vibration, reduce the possibility of ice crust formation, increase adhesion, shorten the braking distance and, in addition, can be 1.5-2 times thinner

Rubber waste was used to modify bitumen grades TB 25/40, TB 70/30 and Wax 85/25. The physical and mechanical parameters of the bitumen used are shown in Table 1, and the formulation based on rubber dust is shown in Table 2. Subsequently, on the basis of the obtained mineral powders and active bitumen (B75), an asphalt-concrete mixture of the following composition was prepared: (mass parts); RK -; bitumen -; high molecular weight petroleum acid and sulfur.

Table 1. Composition formulation based on rubber dust (RP).

Component name	№ Sample				
	1	2	3	4	5
	Content of mass parts				
Bitumen	100	100	100	100	100
rubber crumb(RC)	2	4	6	8	10
Sulfur	-	2	2	2	2
high molecular weight petroleum acid	2	3	4	5	6

Table 2. Basic properties of original and modified bitumen.

Defining properties	Initial bitumen	modified bitumen		
		Sample3	Sample4	Sample5
Depth of needle penetration at 25C, mm / 10	65	50	37	25
Softening temperature according to "KiSh", ° C	80	84	91	95
Elongation, sm	65	51	46	25
Brittleness temperature according to Fraass, °C	-10	-5	-2	0

In a number of experiments, high molecular weight petroleum acid was first mixed with the mineral components of asphalt concrete using standard mixing equipment, then the mixture was poured with hot bitumen and additionally mixed for only 50-100 seconds.

Despite such a short mixing time, effective formation of strong bonds between the rubber powder particles, bitumen molecules and high molecular weight petroleum acid occurs. As a result, the temperature coefficient of strength of asphalt concrete significantly decreases, the softening temperature of the road surface does not increase. In the future, we added other components to the composition of the compositions (table3)

Table 3. Composition of bitumen-polymer compositions

Composition components	Content of components, wt. parts. By examples								
	1	2	3	4	5	6	7	8	9
Rubber crumb	-	5	10	15	20	25	30	35	40
Bitumen	200	200	200	200	200	200	200	200	200
Filler	200	200	200	200	200	200	200	200	200
Mineral powder (NMP)	150	-	-	-	25	40	50	60	80
high molecular weight petroleum acid	-	-	-	-	10	10	10	20	20
Mixing temperature of components in the mixer, ° C	100	70	90	100	160-180	70	90	70	100
Mixing time, min	15	10	12	15	65-120	10	12	10	15

he resulting granulated bitumen-rubber composition was tested according to standard procedures. The data are presented in tables 4, 5 and 6.

Table 4. Indicators of physical and mechanical properties of asphalt concrete mixture

Indicator names	Samples			
	1	2	3	4
Compressive strength, MPa, At 20 ° C / 50 ° C	2,2 / 0,9	- / -	- / -	- / -
Water resistance coefficient,%	0,90	-	0,95	0,89
Water resistance coefficient at long-term water saturation,% by volume	0,86	0,90	0,94	0,90
Swelling,% by volume	0.6	0,9	0,5	1,0
Residual porosity,% by volume	2,1	2,4	2,0	2,3

Table 5. Properties of bitumen-polymer compositions

Indicators	Indicator values by example								
	1	2	3	4	5 prototype	6	7	8	9
Tensile strength at break, MPa	4,5	10,0	6,0	6,5	Tears without load	7,0	8,0	5,0	9,5
Elongation at break,%	650	850	1100	780	-	900	900	700	830
Elongation at break,%	63	50	35	58	20	45	43	40	45
melt flow rate at T = 190 ° C, P = 49 N, g / 10 min	18	20	40	35	100	30	35	30	25

Table 6. Physical and mechanical properties of crushed stone-mastic asphalt concrete ShchMA-10 with the introduction of RS on stone materials

№	The name of indicator	Standards in accordance with GOST 31015-2002	0 %	0,1 %	0,2 %	0,3 %	0,5 %
			rubber crumb				
1	Density (bulk density), g / sm3	-	2,39	2,40	2,40	2,41	2,41
2	Residual porosity,%	2,0–4,0	3,761	3,358	3,358	2,956	2,956
3	Water saturation,% by volume	1,5–4,0	2,82	2,33	2,23	2,16	2,01

4.	Compressive strength, MPa at temperature: 200 ° C 500 ° C	- 2,5-0,70	3,29 0,75	3,52 0,87	3,67 1,00	3,99 1,11	4,12 1,12
5.	Water resistance coefficient,%	-	0,86	0,92	0,94	0,95	0,97
6.	Water resistance coefficient at long-term water saturation,% by volume (15 days)	0,75	0,79	0,86	0,88	0,91	0,92
7.	Crack resistance - ultimate tensile strength at fracture at a temperature of 0 ° C, M	3,0 – 6,5	3,48	3,82	3,99	4,21	4,16
8.	Internal friction coefficient tg	0,94	0,89	0,90	0,92	0,92	0,91
9.	Shear adhesion at a temperature of 500 ° C, MPa	0,20	0,18	0,33	0,57	0,60	0,65
10.	Binder runoff rate,%	0,20	0,24	0,19	0,18	0,15	0,13

As can be seen from the data, the introduction of 2 wt% active rubber powder into grade A asphalt with good properties leads to a twofold increase in its softening temperature, while the frost resistance and elasticity of the asphalt concrete increase.

As laboratory studies have shown, this technology of introducing active rubber powder is not accompanied by the destruction of macromolecules, which provides quite satisfactory elastic properties of the road surface.

Fine-dispersed technical carbon from rubber, getting into bitumen in large quantities, became an additional source of crystallization centers, sharply reducing the stability of binders, their resistance to aging and degradation of properties.

Conclusions

The work carried out has shown a significant advantage of asphalt concrete based on a composite bitumen-rubber binder in the construction of the upper layers of coatings in comparison with traditional hot asphalt mixtures. The data obtained allows that this research will be implemented in the construction of highways in areas where in summer the air temperature overheats more than 45-50 °C

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