American Journal of Interdisciplinary Research and Development
ISSN Online: 2771-8948
Website: www.ajird.journalspark.org
Volume 28, May - 2024

USE OF RUBBER WASTE TO MODIFY THE BINDER IN ASPHALT CONCRETE

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Abstract
The development and implementation of road surfaces resistant to temperature extremes and high technogenic loads is one of the important tasks for road workers. These surfaces must be economically viable for production. Since the known methods for improving the physicomechanical properties of a binder for asphalt concrete involve the introduction of expensive foreign polymers. Rubber crumb, being a waste of production, allows to solve the problem with the disposal of used tires, and the cost of such a modifier for road bitumen is lower than foreign polymers. The article describes an example of using a rubber crumb to modify the road binder in asphalt concrete. The compositions of bitumen-rubber suspensions, the determination of the physicomechanical properties of a modified binder are described. The test results of asphalt concrete with a bitumen-rubber binder are given. A comparative analysis of asphalt concrete on bitumen oil road viscous and asphalt concrete on a modified binder is carried out. The purpose of this work is to develop a theoretical justification and practical application of a bituminous-rubber binder obtained by combining oil road bitumencomposite surpasses viscous petroleum bitumen in physical and mechanical properties and is suitable for use as a binder for the production of high-quality asphalt concrete.

Keywords: bitumen, crumb rubber, physical and mechanical properties, oil pitch, oil fuel.

Introduction

In the process of human production and household activities, a large amount of waste is generated, in particular polymers [1]. Polymers are high molecular weight compounds having different chemical compositions and structures. Polymers include thermoplastics, thermoplastic elastomers, and elastomers (rubber-like and caoutchoucs). Existing technologies for using recycled rubber raw materials solve the problem of specific production, and household elastomer waste remains without attention. In the north of Russia, there is a big problem of recycling used car tires [2]. Used car tires are transported to waste quarries for disposal. Where rubber deteriorates during the aging process, environmental pollution occurs accordingly [3].

To reduce the environmental load, integrated approaches are needed for processing rubber waste and man-made rubber raw materials (car tires), and the development of new environmentally friendly technological processes [4]. Used car tires are consumer waste. The main product of tire processing is crumb rubber [5].

MATERIALS AND METHODS

The starting materials for the preparation of the binder were crumb rubber of 2.5 mm fraction, petroleum pitch, petroleum fuel oil and viscous petroleum road bitumen grade BND 100/130. The physical and mechanical properties of the binder were determined using instruments: softening temperature using a KiSh-20M4 instrument, brittleness temperature using an ATX-20 instrument, elongation using a DB-2M instrument, adhesion to stone materials using a 1000 ml container and a tripod.

To prepare asphalt concrete type B grade II, mineral materials were used: crushed stone from gravel from the Irkutny quarry, fraction from 5 to 10 mm and St. 10 to 20 mm, sand from crushing screenings of the Irkutny quarry, large class II, mineral powder from carbonate rocks from the Pereval quarry.

The formation of asphalt concrete samples was carried out on an IP-1A-500AB press, with a mold with a diameter of 71.5 mm. The physical and mechanical properties of asphalt concrete were measured using the following instruments: on a DTS-06-50 press, compressive strength at temperatures of 20 °C, 50 °C and 0 °C, determination of the ultimate strength of water-saturated samples; When determining the average density and water saturation, electronic laboratory scales VLTE-2100/5100 with a capacity of 20 liters were used.

At the first stage, a modified binder for asphalt concrete was produced. Initially, we produce 5 binder compositions with different contents of crumb rubber, petroleum pitch and fuel oil. Add crumbled rubber, petroleum pitch and fuel oil to the bitumen, heated to a liquid state in a drying cabinet at a temperature of 150 °C.

The components were dosed as a percentage of the bitumen content; bitumen is taken as 100. The percentage ratio of components is given in Table 1

Table 1 Component ratios

#	Componen	Train numbers					
		1	2	3	4	5	6
1	Bitumen	100	100	100	100	100	100
2	Rubber crumb	1	2	3	4	5	6
73	Petroleum fuel oil	2	3	4	5	6	7
4	Oil pitch	5	10	15	20	25	30

The components are mixed in a sealed reactor under the influence of microwave radiation with constant stirring. The gases formed in the process enter the heat exchanger and are discharged into the receiving tank. [6]

Mixing was carried out for 2 hours at a temperature of 185 °C. Next, the compositions were further processed on a high-speed dispersant for 10 minutes at a temperature of 160 °C. The results for determining the physical and mechanical properties of the binder are given in Table 2

Table 2 Results of physical and mechanical tests of binder

#	Indicator name	Composition number	indicators	
			Unit value	Average value
1	Softening point, °C	1	+46,5 +46,5 +46,5	+46,5
		2	+46,5 +46,5 +46,5	+46,5
		3	+46,5 +46,5 +46,5	+46,5
		4	+46,5 +46,5 +46,5	+46,5
		5	+46,5 +46,5 +46,5	+46,5
2	Brittleness point, , °C	1	+46,5 +46,5 +46,5	+46,5
		2	+46,5 +46,5 +46,5	+46,5
		3	+46,5 +46,5 +46,5	+46,5
		4	+46,5 +46,5 +46,5	+46,5
		5	+46,5 +46,5 +46,5	+46,5
3	Extensibility at 0 °C, sm	1	+46,5 +46,5 +46,5	+46,5
		2	+46,5 +46,5 +46,5	+46,5
		3	+46,5 +46,5 +46,5	+46,5
		4	+46,5 +46,5 +46,5	+46,5
		5	+46,5 +46,5 +46,5	+46,5

RESULTS

The results of tests for adhesion to stone materials, such as granite, basalt and crushed gravel, compositions No. 1 and No. 2 did not withstand the test for granite, all other compositions for all stone materials passed the test.

DISCUSSION

Based on the results given in Table 2, we can conclude that compositions No. 4 and No. 5 are homogeneous in their content, the rubber crumb has dissolved, which indicates high physical and mechanical test results, high softening temperature, low brittle temperature and fairly good elongation. Compositions No. 4 and No. 5 were selected as binders for asphalt concrete.

CONCLUSIONS

The studies carried out in this work show that the addition of crumb rubber to bitumen can increase its physical and mechanical properties, such as softening point, brittleness temperature and extensibility [8]. The result is a binder that is practically an analogue of polymebitumen binder, only using waste rubber.

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