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POLYMER-MODIFIER FOR THE ROAD BITUMEN MANUFACTURE OF THE FOURTH GENERATION

YULIYA BULAUKA, TATSIANA LEBEDZEVA
Polotsk State University, Belarus

The article describes a polymer-bitumen composition based on petroleum road bitumen and a polymer modifier obtained from petrochemical wastes, which is distinguished by the use of cheaper and more accessible components compared to industrially used analogs. Moreover, it approaches the requirements for modified bitumen in terms of its basic performance indicators, ensuring their reliable operation in the composition of asphalt concrete mixtures.

In the recent years, two contradictory trends have been observed in the production of road bitumen by the method of air oxidation. On the one hand, road bitumen consumers require the manufacturer to improve the quality of road bitumen. The reason for this is the growth of the vehicle fleet and increasing load on the road bed. In this regard, a new standard GOST 33133 was accepted. It establishes stricter requirements for the quality of road bitumen. On the other hand, the deepening of oil refining at oil refineries changes the ratio of the main components in tar and creates significant difficulties in obtaining high quality commercial bitumen by direct air oxidation. All this demands modernization of the existing refinery industries to produce road bitumen that meets the requirements of the new GOST 33133, while bitumen production, unlike that of light oil products, does not make much profit for oil refineries. Therefore, such upgrades are mostly unprofitable [1-2].

From a technological and economic point of view, it is advisable to obtain polymer bitumen compositions in order to improve the operational properties of bitumen for road construction. Polymer-modified bitumens provide a high level of performance indicators, such as heat resistance, resistance to shear, long-term strength and resistance to low-temperature cracking. Currently, more than 10% of road bitumens produced in European countries contain polymer additives. However, the use of polymers is one of the most expensive ways to modify them; the introduction of a small amount of polymers into bitumen increases its cost more than twice [3].

The aim of this study is developing a polymer-bitumen composition based on oil road bitumen and a polymer modifier. The latter is obtained from petrochemical waste of polymer production, which differs by the use of cheaper and more accessible components compared to industrially used analogs. In terms of its main performance indicators it approaches the requirements for modified road bitumens, ensuring their reliable operation in asphalt concrete mixes. It has been determined that the joint influence on the bitumen structure of the components of the combined polymer-modifier additive allows to increase the softening temperature and at the same time the needle penetration depth. It also increases elasticity, lowers the brittleness temperature, ensures the plasticity interval and penetration index required by the standards, improves adhesion to the surface of mineral materials, with the satisfactory resistance of the polyethylene bitumen composition to aging. All these factors brought together will increase strength and heat resistance of the polymer EP-bitumen compositions, as well as plasticity, elasticity, frost resistance, which allows to predict high quality of the road surface.

Modification of bitumen was carried out by hashing components in metal capacity at a temperature of receiving asphalt concrete of 130-160 °C within 30 min. an anchor mixer with a speed of rotation of 60 rpm [4-7]. During the research of the modified bitumen standard methods of definition were used:

– softening temperatures on a ring and a sphere in accordance with GOST 11506;
– tensile properties at + 25 °C according to GOST 11505;
– penetration according to GOST 11501;
– temperature of fragility according to GOST 11507;
– index of penetration according to GOST 22245;
– solidification resistance at 163°C according to GOST 18180;

It has been revealed that a synergistic effect leading to an improvement in the properties of polymer-bitumen compositions occurs only after pre-mixing the components of the polymer modifier and plasticizer and their subsequent heat treatment, and at the temperature of 100-120 °C for 90...120 minutes with constant stirring. To bring the main indicators of the quality of road bitumen to modern standards' requirements, it is proposed to use a thermally prepared combined additive with a concentration of up to 3% by weight. The cost of raw components of the combined additive is equal to the cost of the commercial road bitumen itself.

For industrial implementation it is proposed to use a 1% combined additive obtained by mixing 1 part of plasticizer and 2 parts of polymer production waste. This will bring the main quality indicators of road bitumen of the BND 70/100 (petroleum road bitumen) in the line with the requirements of modern standards, the actual values of the proposed polyethylene bitumen composition are given in table 1.

Table 1. – Actual quality indicators of Bitumen BND 700/100 and polyethylene-bitumen composition based on BDN 70/100

Main indicators	Requirements for BND 70/100		Actual value for BND 70/100	Bitumen composition with 1% of mass additive
	STB EN 12591	GOST 33133		
Penetration according, 0,1 mm at 25 °C (GOST 11501)	70-100	71-100	65,2	86,3
Softening temperatures on a ring and a sphere, °C (GOST 11506)	43-51	>47	44,5	46,5
Tensile properties, cm at 25 °C (GOST 11505)	не норм.	62	61,5	64,5
Temperature of fragility, °C (GOST 11507)	<-10	<-18	-15	-25
Index of penetration (GOST 22245)	-1,5… 0,7	-1…1	-1,46	-0,92
Solidification resistance at 163°C according to GOST 18180:				
changes in softening temperatures, °C	≤9	≤7	4	7
changes in the mass, %	≤0,8	≤0,6	0,06	0,03

The joint effect of the components of the combined additive on the structure of bitumen can significantly increase its strength and heat resistance, resistance to rutting at elevated temperatures, as well as plasticity, elasticity and crack resistance; improve adhesion of mineral materials to the surface, which allows to predict high quality of the road surface. Polymer production wastes are promising modifiers in polymer-bitumen materials production.

The proposed polymer-bitumen composition differs from industrially used analogs by the use of cheaper and more accessible components, and in terms of its basic performance indicators it approaches the requirements for modified road bitumens, ensuring their reliable operation in asphalt concrete mixtures.

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