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TECHNOLOGY OF DISPERSED REINFORCEMENT OF ASPHALT CONCRETE MIXTURES WITH CHRYSOTILE FIBRES

Problem statement. The issues of technology of preparation of dispersed reinforced asphalt concrete mixtures are still not clearly understood. Available technologies of dispersed reinforcement involve application of granulated additives, which permits the quality of asphalt concrete mixtures to be improved and, therefore, it will result in increasing life expectancy of asphalt concrete pavements.
Results and conclusions. The ways of improvement of quality and durability of asphalt-concrete pavements by reinforcing with chrysotile fibres are considered. The peculiarities of preparation of asphalt concrete mixtures reinforced with chrysotile are revealed. The results of monitoring of fibre reinforced asphalt concrete pavement in 2 years are presented.

Keywords: chrysotile, fibres, asphalt concrete, bitumen, road surface, technological scheme.

Introduction

Life expectancy of asphalt concrete road pavements is significantly lower than it is prescribed by standards. One of the ways of increasing pavement life expectancy is dispersed reinforcement of asphalt concrete mixtures used in paving.

However, the issues of technology of preparation of dispersed reinforced asphalt concrete mixtures are still not clearly understood. Available technologies of dispersed reinforcement involve application of granulated additives, which permits the quality of asphalt concrete mixtures to be improved and, therefore, it will result in increasing life expectancy of asphalt concrete pavements.

Dispersed reinforcement with chrysotile fibres improves the whole complex of characteristics of asphalt concretes and greatly influences the properties of bitumen films which play the most important role in the processes of asphalt concrete aging. In this connection two-stage technology of introduction of chrysotile fibres during the process of asphalt concrete mix production was developed. The technology makes it possible to reduce the rate of selective filtration of the components of oil bitumen in pores and capillaries of mineral material, thus improving the properties of bitumen in adsorption layer and making prerequisites for increased life expectancy of asphalt concrete pavements.

From the technological point of view, dispersed reinforcement with low-grade fractions of chrysotile fibres is simple, economic and environmentally-friendly method. Based on researches conducted earlier [1, 2], technological scheme of production of asphalt concrete mixtures reinforced with chrysotile fibres was developed (Fig.) [3]. The technological scheme consists of two lines. In the first line, fractions of stone materials are produced, in the second line, reinforced asphalt concrete mixture is obtained.

Technological line for production of stone material fraction consists of stores of stone material, band conveyor, drying drum, elevator, sifters, hoppers for dispersed fractions of stone materials: 0—5 mm and 5—20 mm, weighing hopper, mixing machine, hopper for the storage of the finish mix.

To prepare chip-sand fractions with particle size 0—5 and 5—20 mm, any stone material which meets the requirements of State Standard (ГОСТ) 9128-97 can be used as raw material. These materials are transported to the plants. After unloading, stone materials are charged into the receiving hopper by bulldozer. After that, materials enter the drying drum with the use of conveyor. After drying in a drum, waste products enter the sifter, where they are dispersed into fractions with particle size 5—20 mm and 0—5 mm. These fractions enter a hot hopper and thereafter a weighing hopper of asphalt concrete plant.

Technological line for producing the asphalt concrete mixture consists of hoppers for raw material, metering device, collection reservoir, mixing machines. Mineral powder and chrysotile fibres are fed in additional gravitational cyclic mixing machine СБР-320 from hoppers through the metering device. After mixing, dispersion medium is homogenized. After that, mixture feeds into the mixing machine. The same mixing machine receives fractions with particle size 0—5 mm (sand), crushed stone (fraction) with chip size 5—10 and 10—20 mm; bitumen БНД 90/130 is fed from bitumen boilers through metering device.

On further mixing of all components, dispersed reinforced asphalt concrete mix is obtained.

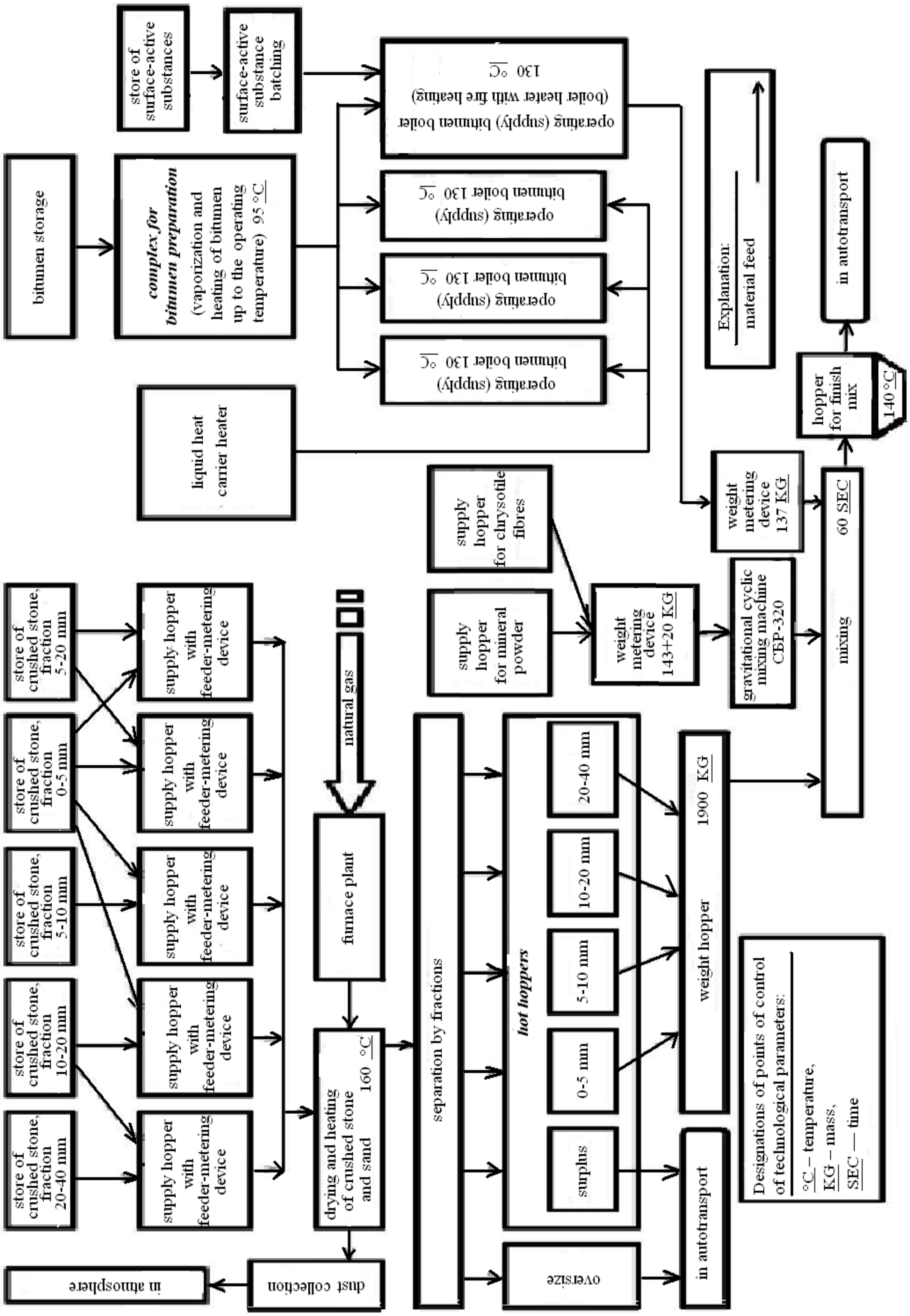

Fig. Flowchart of production of asphalt concrete mix reinforced by chrysotile fibres

A distinctive feature of the technological scheme of dispersed reinforced asphalt concrete mix Production is the necessity of storage of mineral powder and chrysotile fibres in hoppers. In this case dispersed medium is homogenized due to the mixing of mineral powder with chrysotile fibres in additional gravitational cyclic mixing machine.

The sequence of preparation is as follows: in initial stage chrysotile fibres are mixed with mineral powder in additional gravitational cyclic mixing machine СБР-320.

Obtained mix is fed into the main hopper, where sand and crushed stone (chip size is 5—20 mm) are added. Accuracy of batching should be ±3 % for sand and crushed stone fractions, ±1.5 % for mineral powder, chrysotile fibres and bitumen. Bitumen of type БНД 90/130К heated to 130° C was added to obtained fibre-mineral part heated to 160 °С. All the components were mixed during 60 sec. This mixing resulted in formation of dispersed reinforced asphalt concrete mix. The temperature of finish mix is 140 °С.

To build the pilot area, hot dense concrete mix of type Б and grade I was obtained.

The pilot area of automobile road of class III "Mezenskaya-Kurmanka-Boyarka" was built on 25th of June, 2007. Total length of the road is 150 rm, area is 1350 m^2. The area was built using technology of dispersed reinforcement of asphalt concrete mixes with chrysotile fibres. The results of tests of asphalt concrete in 2 years are tabulated.

Table

The results of physico-mechanical tests of core samples,
taken from the upper layer of pavement from dispersed reinforced hot dense
fine-grained asphalt concrete mix of Б-type

Characteristic	Results of tests		Requirements	
	2007	2008	Sanitary code (СНиП) 3.06.03-85	State Standard (ГОСТ) 9128-97 I grade
Core Samples				
1. Design layer thickness, mm	50	50		
2. Actual thickness, mm	50	52	Pass-off standard ± 10 мм	
3. Average density, g/cm^3	2350	2330		Is not rated
4. Water saturation, % by volume	2.63	3.94		No more than 4.5
5. Cohesion with underlayer	Provided	Provided	Should be provided	
6. Coefficient of compaction	1.00	0.99	Not less that 0.99	

End of Table

Characteristic	Results of tests		Requirements	
	2007	2008	Sanitary code (СНиП) 3.06.03-85	State Standard (ГОСТ) 9128-97 I grade
Reformed samples				
7. Average density, g/cm^3	2350	2350		Is not rated
8. Water saturation, % by volume	1.26	1.92		
9. Ultimate compression strength, MPa, at temperature: 20 ^{0}C 50 ^{0}C	 3.8 2.0	 3.9 1.9		
10. Ultimate compression strength after water saturation, MPa	3.6	3.6		
11. Coefficient of water resistance	0.95	0.96		

Monitoring of asphalt concrete pavement during service life have shown that coefficient of cohesion is constant and ranges from 0.35 to 0.37, which made it possible to depart from additional surface treatments.

Summary

Dispersed reinforcement with chrysotile fibres results in improving characteristics of asphalt concrete at positive temperatures. Two-stage technology of chrysotile fibres in production of asphalt concrete mix helps to reduce intensity of crack formation at negative temperatures, which leads to increasing life expectancy of asphalt concrete. Essential modernization of equipment and retraining of workers of asphalt concrete plants are not required, which has positive impact on the cost of asphalt concrete mix. The technology of introduction of chrysotile fibres in bitumen does not require heating of bitumen to high temperatures. This fact also has good impact on the mix cost.

References

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