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ENSURING INCREASED DURABILITY OF PAVEMENT ON REINFORCED CONCRETE ROAD BRIDGES

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Bridge structures, vehicular traffic, car tires, grafting coefficient, road bridges.

ABSTRACT

The article contains the results of a study on increasing the durability of pavement on reinforced concrete road bridges by using rubber crumb. The pavement on reinforced concrete road bridges is one of the main structural elements of the structure, the technical condition of which affects the safety of the structures as a whole.
Given the constant increase in traffic intensity and load on the road network, as well as insufficient funding for major repairs or reconstruction, it is necessary to use materials that ensure reliable operation of the roadway of bridge structures to increase the durability of the asphalt pavement.
The asphalt concrete pavement of a roadway has a number of important factors that ensure the safety and comfort of vehicular traffic, namely: flatness, low noise and roughness, which provides the necessary grafting coefficient with the car tires while driving. However, it should be noted that during operation, such a coating is easily exposed to unfavorable factors, which leads to premature deformation in it.

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Introduction.

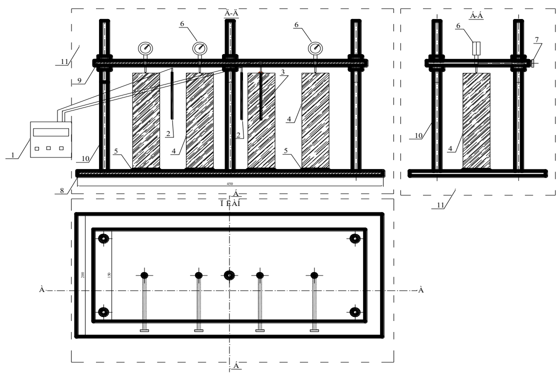
One of the main reasons for the decrease in durability due to the formation of defects (cracks, ruts, displacements, etc.) on the pavement of road bridges from the joint action of pneumatic wheels of vehicles and temperature changes, which leads to the loss of structural bonds between the layers of asphalt pavement, waterproofing and reinforced concrete base of the bridge deck, which is primarily due to the low physical and mechanical properties of asphalt concrete on bituminous binders, as well as the difference in the coefficient of thermal deformation of the pavement and reinforced concrete base is an urgent scientific research. Currently, in order to improve these indicators, in domestic and foreign practice, bitumen binders are modified with various types of modifiers, including modifiers of various types, rubber industry waste, etc. It should be noted that one of the promising methods of improving the performance of asphalt pavement is the use of rubber crumb to modify bituminous binder or asphalt mixtures directly.

One of the advantages of using rubber crumb in asphalt mixtures is an increase in the service life of the road surface [1]. The advantages of using a rubber crumb modified bitumen binder are less sensitivity to daily temperature changes, greater resistance to deformation at higher pavement temperatures, proven aging resistance properties, higher fatigue strength of mixtures, and better adhesion between aggregate and binder [2, 3, 4, 5].

Presentation of the main material.

To determine the durability of asphalt pavements, a study was conducted to determine the coefficient of linear thermal deformation. To conduct the study, the equipment shown in Fig. 1 and asphalt concrete samples prepared from asphalt concrete mixtures of the B-10, B-20, SCA-10, SCA-20 types were used [6, 7].

The essence of this technique is that the asphalt concrete sample is attached to the bottom plate using alabaster, and a clock-type indicator is fixed on the top plate to measure the linear deformation of the sample. To stabilize the cooling and heating temperature of the specimen, 24 hours after molding, a 4 mm diameter hole is made in the end of the specimen, into which the end of the thermocouple is immersed to a depth of 60 mm. The other end of the thermocouple is fixed next to the samples to fix the temperature in the freezer.The samples with the device were placed in a thermocouple and cooled to -20 °C. The initial temperature was set and the initial reading was taken from the indicator.



1 - five-channel temperature meter; 2 - resistance thermocouple; 3 - resistance thermocouple in the sample; 4 - sample; 5 - alabaster; 6 - clock-type indicator with a division price of 0.01 mm; 7 - screw; 8 - bottom plate of the device; 9 - top plate of the device; 10 - rack; 11 – freezer.

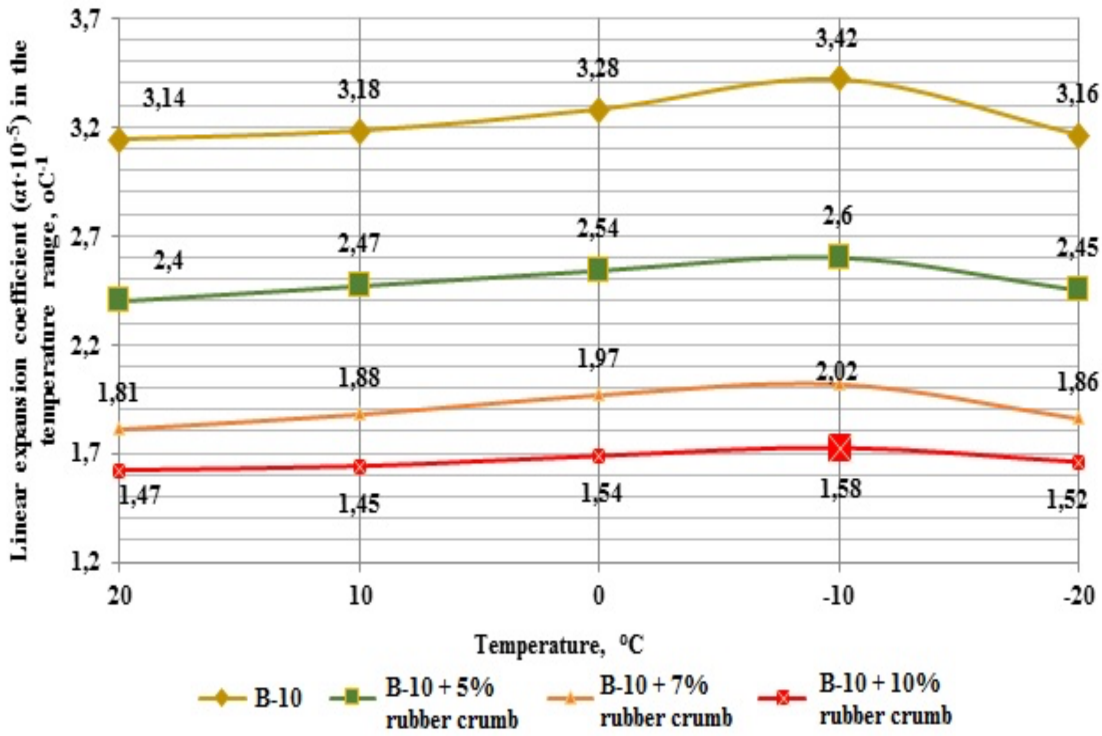
Figure 1. Device for determining the linear temperature deformation coefficient α.

When the test temperature reached -20 °C, further freezing was stopped and the sample was heated to a temperature value of +20 °C. At each set test temperature, the specimen was heated for 15 minutes, after which it was counted by the indicator. The coefficient of linear thermal deformation was determined by formula (1) [6,7], was taken into account, taking into account the thermal deformation of the vertical racks of the device:

$$\alpha = \frac{(n_1 - n_2)}{l(T_1 - T_2)} + \alpha_{CT}, \tag{1}$$

де: n_1 та n_2 – readings on the indicator (mm), respectively, at temperatures T_1 і T_2; l – sample length (mm); α_{CT} – temperature deformation coefficient of the tripod stand [22, 47].

The results of determining the coefficient of linear temperature deformation are shown for the tested asphalt concrete specimens made of asphalt mixtures of B-10, B-20, SHMA-10, SHMA-20 types in Fig. 2-5. From the results of the studies, it can be concluded that with an increase in the content of rubber crumb in the bituminous binder and asphalt concrete mixture, the value of the linear temperature deformation decreases. This trend indicates an increase in the temperature crack resistance of asphalt concrete.



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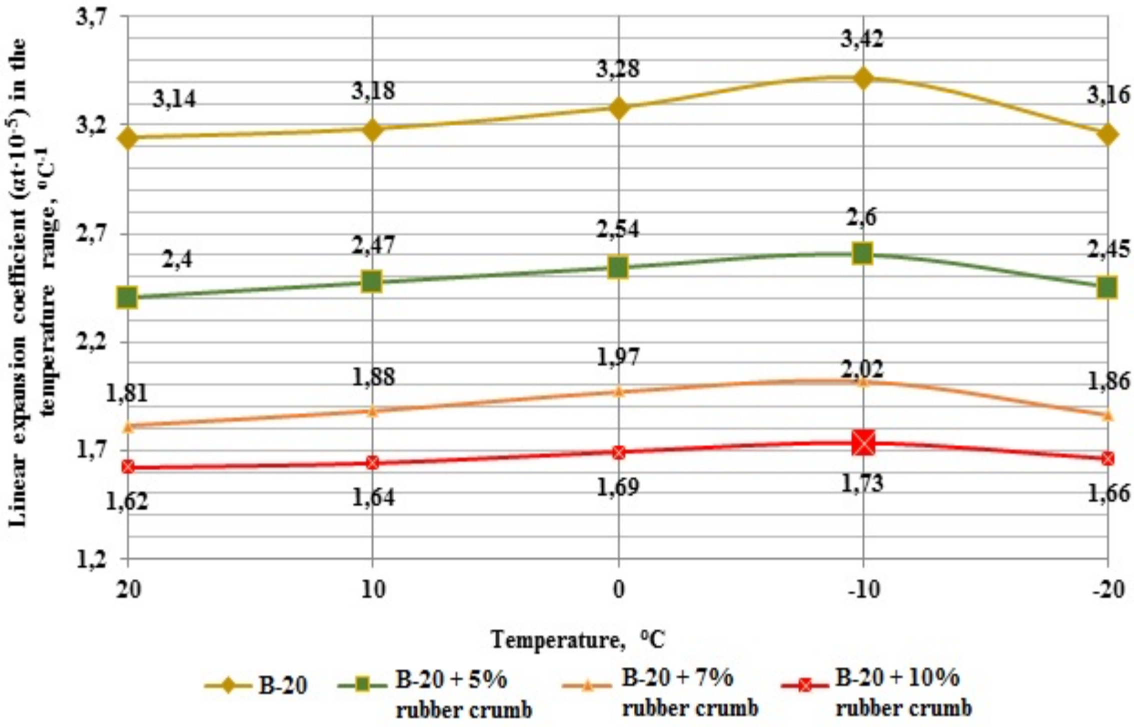

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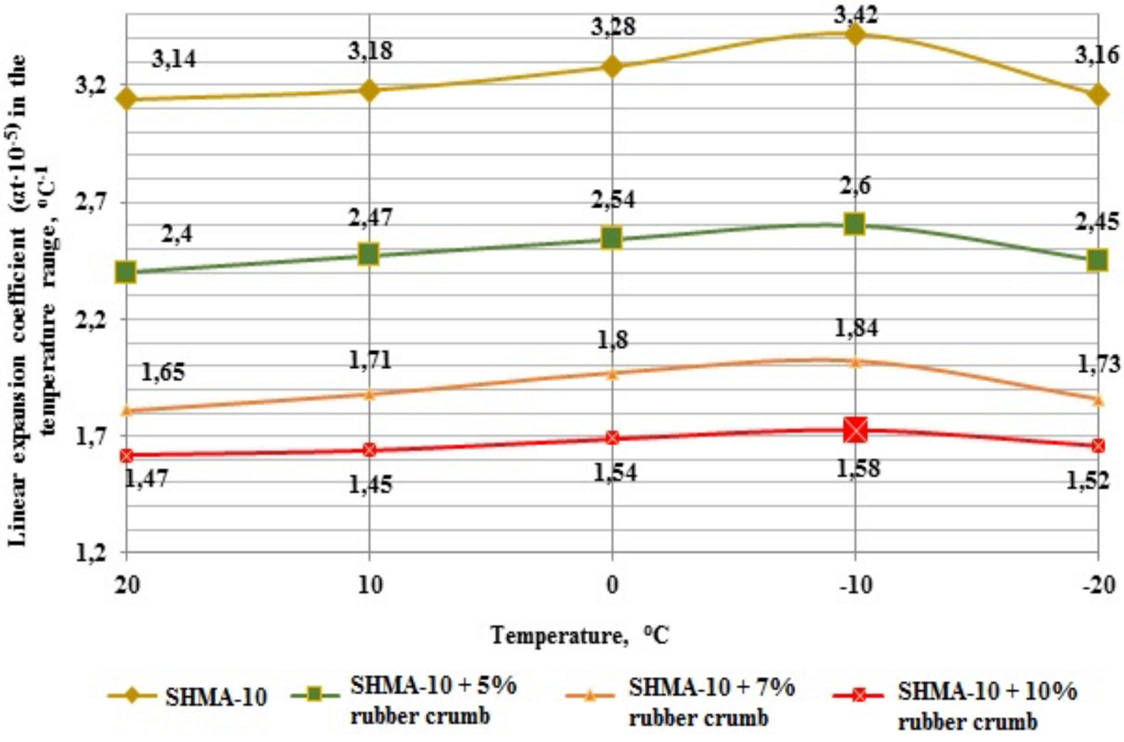

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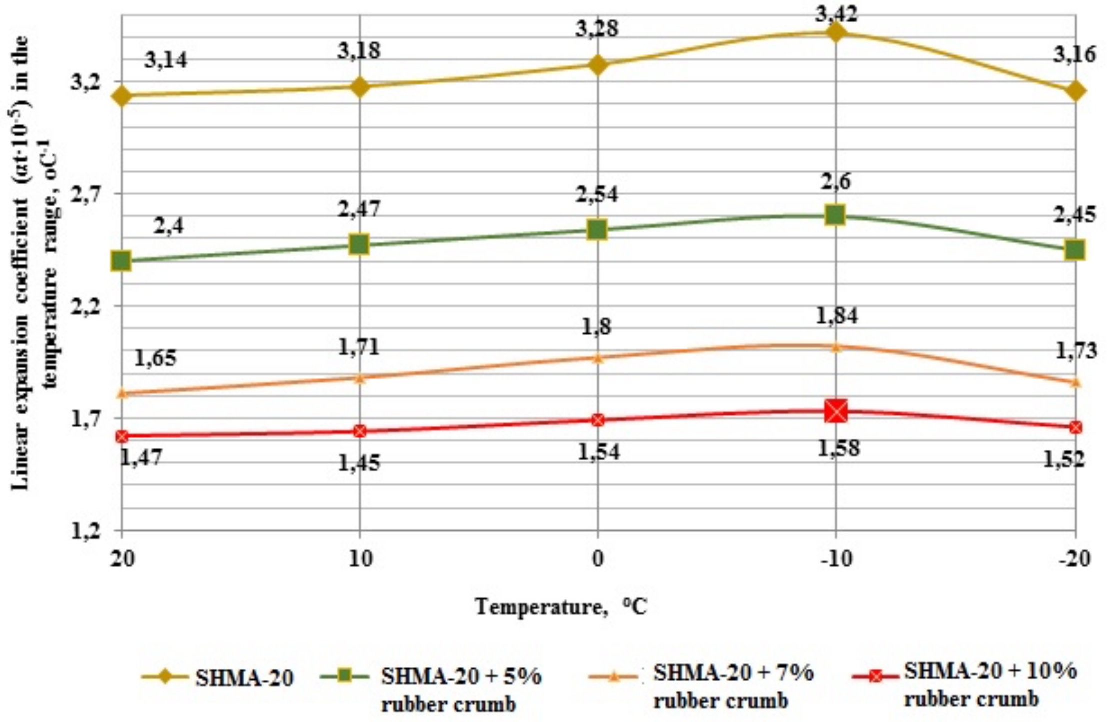


d)

Figure 2. Results of determining the coefficient of linear expansion of the tested asphalt concrete: a) asphalt mix type B-10; b) asphalt mix type B-20; c) crushed stone and mastic asphalt concrete SHMA-10; d) crushed stone and mastic asphalt concrete SHMA-20.

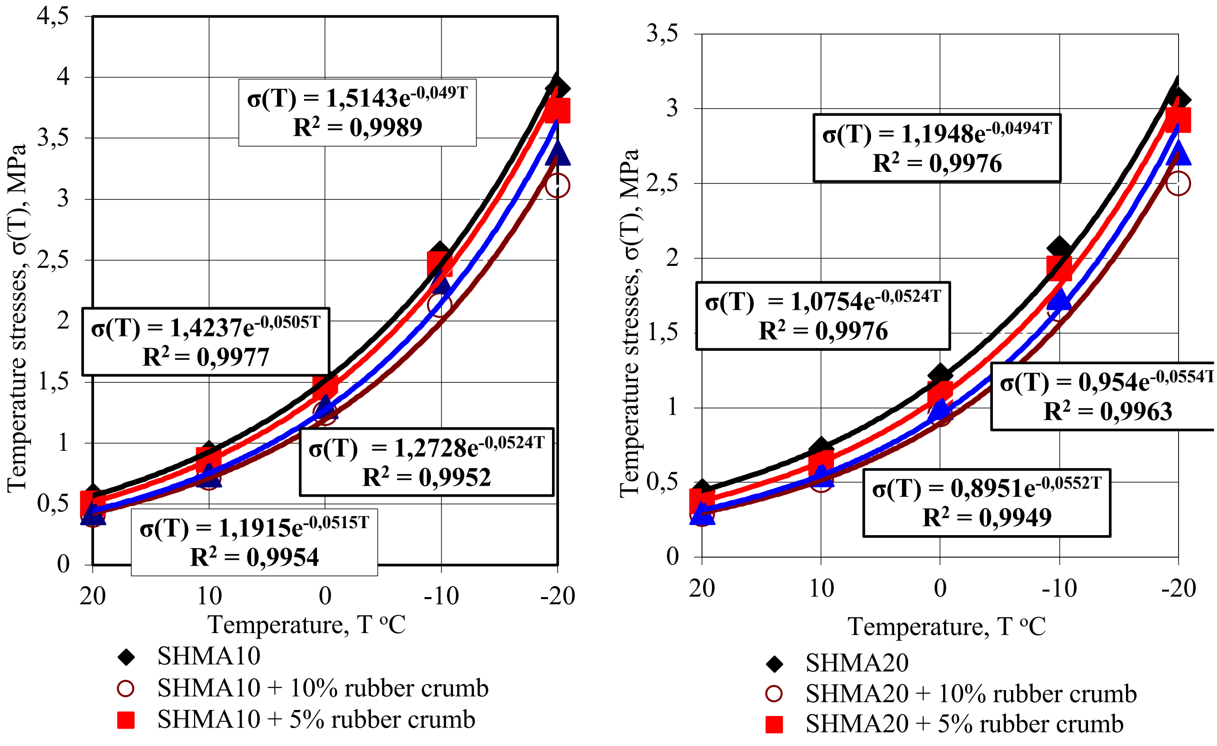
The results of the experimental studies have established the patterns of change in the coefficient of linear expansion, namely, at 7 % rubber crumb in the bitumen binder and 5 % rubber crumb in the asphalt concrete mixture, the coefficient for the studied asphalt concrete decreased by 29 % and 23 %, respectively.

Experimental studies have proven that the coefficient of linear thermal expansion varies with temperature and the amount of rubber crumb in the studied asphalt concrete, and it has been found that crushed stone and mastic asphalt concrete has lower coefficient values on average from 1.037 to 1.089 times, which indicates increased temperature crack resistance compared to fine-grained asphalt concrete type B.

Based on the results shown in Figure 2, the temperature stresses were obtained $\sigma^{аб}{}_{r,(Тем)}(t)$ $=\sigma(T)$), which are used to build graphs of temperature stress dependencies *σ(T)*, that occur in asphalt concrete when the temperature changes (Fig. 3-4).

Figs. 3 and 4 show a decrease in temperature stresses in asphalt concrete with the introduction and increase in the amount of rubber urchin, which in turn indicates an increase in the service life of such asphalt concrete and their residual life.

The analysis of the results obtained in this work shows that the physical and mechanical properties of different types of asphalt concrete differ significantly from each other. Thus, some indicators of one type of asphalt concrete exceed the same indicators of the other, while other indicators show a diametrically opposite situation. This once again emphasizes the fact that standard physical and mechanical indicators make it difficult to justify the decision to use a particular material and determine the type of asphalt concrete to be used as a pavement on reinforced concrete transport facilities, and even more so to predict the residual life and service life of such a pavement.



a) b)

Figure 3. Dependence of asphalt concrete temperature stresses on changes in temperature and the amount of rubber crumb: a) asphalt concrete type SHMA-10; b) SHMA-20.

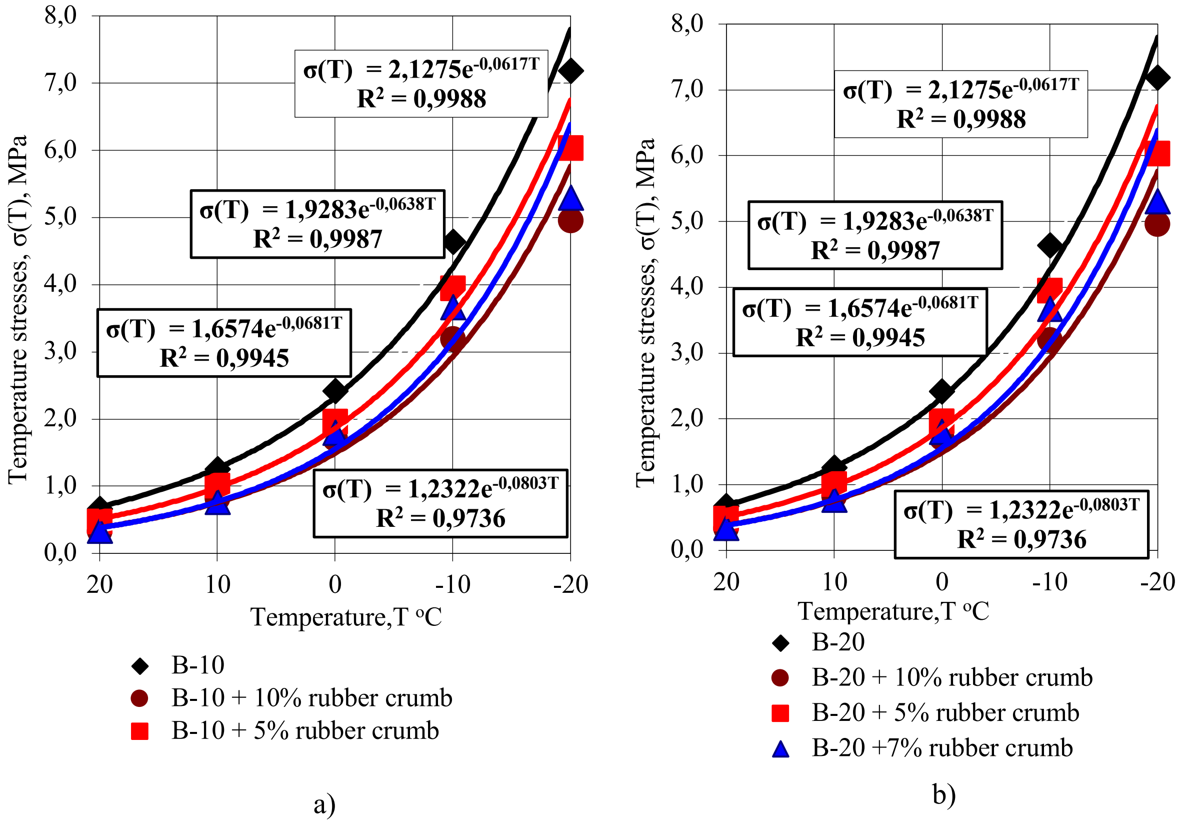


Figure 4. Dependence of asphalt concrete temperature stresses on changes in temperature and the amount of rubber crumb: a) asphalt concrete type B-10; b) B-20.

Conclusions.

The results of laboratory studies to determine the coefficient of linear thermal deformation showed that asphalt mixtures with a certain content of rubber crumb contribute to the durability of asphalt pavements on reinforced concrete road bridges.

Based on the study to determine the coefficient of linear thermal deformation, it can be concluded that the use of rubber crumb for bitumen binder can significantly improve the properties of asphalt concrete. Thus, by providing for the use of rubber crumb pavement on reinforced concrete road bridges, it is possible to ensure its increased durability.

At the same time, crushed stone-matrix asphalt concrete has better experimental performance compared to fine-grained asphalt concrete of type B, which indicates the feasibility of using this pavement directly on transport facilities.

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