Improvement Of Asphalt Concrete Shear Resistance With The Use Of A Structure-Forming Additive And Polymer

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Abstract: The article gives increasing shift fault stability of asphalt in the conditions of Uzbekistan it was searched economic directions of researching of technology for producing viscous bitumen with application of gel forming additives as surface-active agent «SP-EIW».

1. INTRODUCTION
Analysis of the causes of deformation and destruction of roads in Uzbekistan showed that shear deformation, fracture in the form of cracks and potholes, formed due to the use of bitumen of low viscosity, heat resistance and high fragility. In addition, the properties are negatively affected by an overdose of bitumen in the asphalt mixture, which is accompanied by an increase in the volume of bitumen and a decrease in the cohesive strength at high temperatures. At the same time, the use of mineral materials of different nature, which reduce the adhesive strength of bitumen, leads to a decrease in water and frost resistance. The use of a limited amount of crushed sand does not provide the required internal friction of the grain composition between the particles and does not allow to create an optimal dense structure of the road surface frame. Our studies and observations of the condition of road surfaces show that all types of existing damage are mainly associated with insufficient shear resistance and water-frost resistance of asphalt. Providing the necessary shear resistance at high temperatures and water-frost resistance at low temperatures is an important problem in improving the quality of asphalt coatings in Uzbekistan. The resistance of coatings to shear deformation depends on the physical and mechanical properties of asphalt concrete. Deformations can be elastic and residual, characterized by the accumulation of deformation in the form of waves and flows. To improve the shear stability of asphalt concrete in Uzbekistan it is necessary to solve such problems as:
- improving the quality of the components used;
- the use of modifying additives that improve the structure of bitumen and asphalt;
- providing a dense structure of asphalt concrete, resistant to plastic deformation due to the optimal selection of granulometric composition of mineral materials, taking into account the size and shape of the particles;
- increased strength requirements at high summer temperatures. In order to improve the technology of preparation and construction of road asphalt pavements, as well as to improve their shear resistance, a number of effective methods are proposed. Different calculation methods are used to determine the shear stability. In the works of V. Nijboer [1] presented the theory of the strength of the limit stress state theory (Mora) for the mineral materials with organic binders. V. Nijboer paid special attention to the dependence of shear resistance on internal friction, bitumen viscosity and initial resistance of asphalt concrete. According to N. V. Gorelyshev [2], the shear resistance is mainly provided by the grain composition of asphalt concrete. However, to improve the shear stability of asphalt concrete, the greatest impact is made by improving the quality of the components used and the use of modifying additives that improve the structure of bitumen and asphalt concrete. The greatest contribution in this direction was made by professor N. V. Ivanov and his school, the study of which was based on the Coulomb-Mohr theory. In the works of N. V. Ivanov [3] it is shown that in order to avoid plastic deformations in asphalt concrete coatings, it is necessary to increase the shear resistance by increasing the layer thickness. However, it has already been proven that excessive thickening of the coating (more than 10-12 cm) leads to the opposite effect. According to V. A. Zolotarev [4] to improve the shear resistance of asphalt concrete, it is necessary to apply ultrasonic treatment of bitumen and optimally select the grain composition, reduce the thickness of the bitumen film and thereby improve the quality of the contact layer on the surface of mineral materials. However, when using less active bitumen, there is a decrease in adhesive strength, and when using less viscous bitumen without any structure-forming additives, it is almost impossible to significantly increase the cohesive strength between the mineral particles. Temperature dependence of shear stability and deformability of asphalt concrete is the main cause of plastic deformation. Increasing temperature reduces the viscosity of the binder and reduces the bond between asphalt particles especially at high temperatures. Surface-active mineral powder from carbonate rocks has a great influence on the shear stability of asphalt concrete. Insufficient surface activity of mineral powders should be increased by physical and chemical activation. Professor L. B. Gezentsve and his school developed the technology of physical and chemical activation of mineral materials and the basic laws of the properties of asphalt concrete based on it. Physic-chemical activation is subjected to gravel, sand. Its effect on mineral powder is especially effective [5].

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2 METHODS OF RESEARCH

Improving the quality and durability of asphalt concrete coatings, as well as to ensure their targeted regulation is possible by improving the properties of bitumen and the conditions of its interaction with mineral materials. Therefore, in our opinion, in the conditions of Uzbekistan it is expedient to use highly effective structure-forming additives of surfactants and polymers, which lead to improvement of quality indicators of bitumen and, in particular, their viscosity, heat resistance and reduction of brittleness. The cohesive and adhesive strength of bitumen between mineral particles is of particular importance in ensuring shear stability. Therefore, the use of effective structure-forming surfactant additives that extend the plasticity interval, increase the viscosity and heat resistance of bitumen makes it possible to use low-viscosity bitumen in hot asphalt concretes and provide the necessary shear resistance. However, despite the wide range of structure-forming surfactant additives used in road construction in Uzbekistan, their technical characteristics, cost and volume of production do not fully meet the requirements of road construction. The present problems require the search for new highly effective structural surfactant additives, affordable and cost-effective, for example, on the basis of industrial waste, as well as the expansion of their production and application. It is important to solve environmental problems. In the conditions of Uzbekistan, taking into account the requirements of the modern market, we searched for cost-effective directions related to the development of technologies for the production of viscous bitumen with the use of structure-forming surfactants, in order to increase the shear resistance of asphalt concrete coatings. One effective direction is the use of inexpensive structural additions of surfactants "SP-EIW" (solo project from waste electrode industry) developed at the Institute of Chemistry [6]. Our experimental studies of asphalt concrete coatings with the use of modified bitumen with the addition of surfactants have shown the possibility of a significant increase in shear resistance. The tests were carried out according to the method GOST 12801-98 and GOST 9128-13. Before the test, the samples were kept in a thermostat at 500°C for 2 hours. The test results are shown in table 1 and figure 1. The effectiveness of the influence of the structure-forming surfactant additive "SP-EIW" on the shear stability is visible when testing samples with an increase in the amount of the additive. For the purpose of the most clear representation of work of asphalt concrete in an indestructible zone and an assessment of resistance to interaction of the shifting forces it is necessary to define residual deformations at the plastic currents much smaller, than critical. Testing at a temperature of 500°C samples of asphalt concrete with the addition of surfactants "SP-EIW" showed their increased shear strength, that is, an increase in the coefficient of adhesion during shear as uniaxial compression, and according to the Marshall scheme.

The most clearly structure-forming efficiency of the effect of surfactant additive "SP-EIW" on shear stability is visible when testing samples with an increase in the amount of surfactant additive "SP-EIW" 3.0 % by weight of bitumen, (figure 1 and table 1). Earlier studies [8] found that increasing the amount of structure-forming surfactant additive "SP-EIW" in bitumen leads to a significant increase in the softening temperature and viscosity. Therefore, a further increase in the amount of structure-forming surfactant additive "SP-EIW" in bitumen is impractical, since this will increase the stiffness and reduce the elastic-plastic properties of asphalt concrete. It should be noted the great influence of surfactant "SP-EIW" has on the improvement of interaction conditions and properties of bitumen in adsorption layers of mineral powders. At the first stage, due to shear deformations, some displacement of the structure occurs. In this case, the main force perceives the bitumen film and asphalt binder, as evidenced by the small values of internal friction. Further voltage stabilization is associated with the perception of forces by the grain part of the mixture. When the test specimens, the asphalt with the additive surfactant "SP-EIW" showed their increased sdvigovoi at high temperatures and the improvement in the clutch when shifting, as for uniaxial compression, and under the scheme of Marshall, which is associated with structure-forming ability of surfactant additives "SP-EIW" in the bitumen. Thus, the tests carried out for shear stability sufficiently fully characterized the stability of the proposed asphalt concrete at high summer temperatures. Increasing the shear strength of asphalt concrete with the use of surfactant additives "SP-EIW" is mainly associated with an increase in the viscosity of bitumen, respectively, with a high cohesive strength of bitumen films in the contact zone with mineral particles. In addition, the additive "SP-EIW" as surfactant increases the adhesive strength, workability and contributes to the economy of bitumen. [9]. The test results (figure 2) show a great influence of the polymer "SBS Kraton D1101" to improve the elastic properties of bitumen, leading to a decrease in stiffness and an increase in the elastic-plastic properties of asphalt concrete.
The modified bitumen binders proposed by us contribute to a significant change in this indicator, i.e. increase in viscosity and heat resistance with a quantitative change in the structure-forming composition of bitumen. The use of effective polymers, structure-forming surfactant additives that extend the plasticity interval, increase the viscosity and heat resistance of bitumen makes it possible to use low-viscosity oil binders in hot asphalt concretes and provide the necessary shear resistance of the coating.

3 CONCLUSION

Therefore, the tests carried out for shear stability sufficiently fully characterized the stability of the proposed asphalt concrete at high summer temperatures. Analyses results showed that the coefficient of adhesion and internal friction of asphalt during shear increased to 1.5 times, thermal stability (the ratio of compressive strength at a temperature of 500°C to 200°C) increases by an average of 20 %, if you add to the bitumen polymer SBS "Kraton D1101", the coefficient of adhesion of asphalt concrete during shear and fracture of the sample is reduced by about 10 %, the coefficient of internal friction is reduced by 10-15%. These phenomena are associated with an increase in the elastic properties of bitumen in the application of the polymer. Asphalt concrete, prepared on the basis of modified "SBS Kraton D1101" bitumen with the additive surfactant "SP-EIW" meets all the requirements of GOST 9128-2013 and sprosobstvuet to improve the shear resistance at high temperatures of asphalt concrete pavements and increase the longevity of roads.

The use of the recommended structure-forming additive surfactant "SP-EIW" and polymer "SBS Kraton D1101" in asphalt mixtures will improve the shear resistance at high temperatures of asphalt coatings and increase the durability of roads.

REFERENCES