INVESTIGATION OF THE ADSORPTION CAPACITY OF LIMESTONE MINERAL POWDERS IN ROAD CONSTRUCTION

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Abstract. *The article presents. Surface treatment device, The use of thin-layer coatings, Preparation of stable bitumen emulsions, The effect of the surface of the mineral material. According to the results of the analysis, the study of the adsorption capacity of limestone mineral powders in road construction was studied.*

Keywords: *wear layers, emulsion-mineral mixtures, bitumen emulsions, emulsion, crushed stone, cement.*

Introduction

To ensure the design speeds and safety of automobile traffic, especially on modern expressways, it is necessary to have high operational quality of the upper "protective" layers of road surfaces. The upper layers must provide the necessary roughness and evenness, protect the underlying structural layers of road clothing from the access of atmospheric moisture, which is an indispensable condition for the durability of highways [6].

The surface treatment device is the most important type of construction work in the maintenance of highways. To date, various methods of their construction have been developed. However, the most common method was and remains the method of a single treatment device in the form of a rough wear layer. The accumulated experience allowed us to fully and deeply study the nature and features of the operation of rough wear layers [62,64,84].

The use of thin-layer coatings in the repair of existing coatings in some cases seems to be the most appropriate. First of all, this is justified by the high cost and acute shortage of organic binders and high-strength hard-to-grind fractional crushed stone.

In the last decade, there has been a significant advance of new technologies for improving road surfaces in the Republic. This is especially true for the use of emulsions and emulsion-mineral mixtures based on domestic emulsifiers.

At the same time, new technologies for surface treatments are being intensively introduced in the country, one of such technologies is the synchronous distribution of binder and crushed stone (chip forces). This technology involves the use of both bitumen and bitumen emulsions. The temperature of bitumen, and hence its viscosity, does not change significantly during the distribution. The emulsion does not have time to disintegrate. As a result, the crushed stone is well covered with a binder, which makes it possible to use crushed stone not previously treated with bitumen for construction [61]. With the use of bitumen emulsion according to this technology, significant bitumen savings and good fixation of crushed stone on the surface of the road surface are achieved.

The formed layers of emulsion-mineral mixtures have good adhesion to the coating, which is due to the high reactivity of cationic emulsions in contact with the surface of mineral materials of any nature.

The technology of working with these mixtures provides for the formation of a thin layer with a special rough surface texture of the "sandpaper" type during their formation.

Improving the surface characteristics of the pavement, namely, improving traffic safety, is a constant concern of road organizations. Such a layer of wear is arranged on top of asphalt concrete and cement concrete pavement. It creates a good surface texture, reduces splashing of water and dirt, improves visibility for drivers, and also reduces noise [49].

Main part

Preparation of stable bitumen emulsions is impossible without the use of surfactants with the necessary emulsifying and stabilizing properties. The suitability of the emulsion for a particular type of work largely depends on the type of surfactant [21,43,104].

There are many chemical compounds that can be used to emulsify bitumen, but for technical and economic reasons, only a small number of them have become widespread. A significant portion of these compounds can be used alone or in combination with one or more other compounds. They can also be modified in various ways to obtain special properties. A good emulsifier, in addition to providing the emulsions with the appropriate properties, should be cost-effective, safe and easy to operate.

The action of emulsifiers is to create a structural shell around crushed bitumen droplets that does not break when they collide. Therefore, for the preparation of bitumen emulsions, emulsifiers are used, which, having surface activity, are adsorbed on the surface of the droplets, creating stable micelles that do not decay in time. However, the role of the emulsifier is reduced not only to the formation of sufficiently strong protective films around the dispersed phase, its main role is to change the interfacial surface tension, i.e. the emulsifier, being adsorbed on the interface of liquids, should lower the interfacial surface tension and thereby facilitate the emulsification process. Low surface tension has a favorable effect on the stability of emulsions from a thermodynamic point of view.

In bitumen-water emulsions, the emulsifier is mixed to the interface between bitumen and water. The hydrophobic part of the emulsifier molecule retains interaction with the surface of bitumen particles, giving them ionic charges. The hydrophilic part of the emulsifier molecule is located in the aqueous phase.

Results and discussion

There are three most common classification groups of bitumen emulators: cationic, anionic and neutral (not having an ionic charge). Neutral or non-ionizing emulsifiers (i.e. emulsifiers that are superficially active but do not ionize in solution) have very limited use for the preparation of bitumen emulsions. Therefore, next we will consider the effect of only cationic and anionic emulsifiers.

The solution to the issue of regulating the structural and mechanical properties of asphalt concrete depends on the directional structuring of the binder in the layer bordering the mineral material. At the same time, contacts in asphalt concrete, which has an optimal structure, are carried out through layers of structured bitumen. A special role in the processes of bitumen structure formation of asphalt concrete mixture belongs to mineral powder - polydisperse material, which accounts for up to 90-95% of the total surface of the mineral grains that make up the composite

[4,21,37-38]. Combining with bitumen, the micro-filler forms a binary system "bitumen - mineral powder".

For a long time, researchers believed that the purpose
of mineral powder in asphalt concrete is reduced only to filling
intergranular voids, that is, to ensuring proper density, f

The mechanism of action of the micro-filler on the properties of organomineral composites for road surfaces has been studied by many scientists [17,33,36-43]. This contributed to the formation of two fundamentally different concepts about the purpose of mineral powder in asphalt concrete. However, P.V. Sakharov [40] for the first time defined the purpose of mineral powder as a structural component forming together with bitumen an "asphalt binder" that binds mineral grains. Attaching great importance to the role of mineral powder in asphalt concrete, he suggested calling it an "asphalting additive" to bitumen, and recommended using a product of grinding natural asphalt rocks, the so-called asphalt powder, as a mineral powder.

Followers of Sakharov P.V. [17,33,36-38,41-44] considered the filler separately from the rough stone material. It has been established that finely
ground material is not just a void filler - it acts as a bituminous binder modifier.

It was also suggested [39] that the introduction of mineral powder is a method of improving the quality of the mixture with finer grinding of all stone material, and it acts as a filler of voids between particles of small fractions. As a result of increasing the number of contact points between the particles, the strength of the road surface increases.

In most cases of practical use, bitumen, when mixed with mineral fillers of various types, is capable of forming a primary or secondary coagulation structure, the strength of which is largely determined by the properties of the mineral powder [26,52-53]. The formation of the structure of thin films in the boundary layers is influenced by the forces of polarization, induction and dispersion interaction with the surface of mineral particles, which are determined by their common potential [54-56].

It is noted [36-37,57-58] that with a certain ratio of bitumen-mineral powder, the highest strength of the structured dispersed system formed by these materials is achieved. As a result, the resistance of bitumen to shock loads increases, the density of the resulting mass increases, as well as the strength increases under shear and compression stresses, and brittleness decreases. Micro-fillers make it possible to adjust the deformation and reduce the subsidence of the roadbed.

The essence of the process of converting an organic binder into an asphalt binder is to increase the viscosity of bitumen when it is filled with mineral powder. Increasing the viscosity of the binder increases the strength of the bitumen-mineral mixture and increases its heat resistance, characterized by the “ring and ball” indicator [21]. The viscosity of the systems correlates with the average pore diameter in a tightly packed powder.

It is known [59] that there is a certain dependence between the volume content of the mineral powder and the viscosity of the bitumen-mineral mixture. At a certain concentration of powder, the thickness of the bitumen layers on the surface of mineral particles sharply decreases, which leads to a high degree of bitumen structuring, and, consequently, to the strengthening of contacts between grains. However, at low concentrations of filler, the rheological nature of bitumen does not change. The viscosity of the mixture increases depending on the content of the filler. With a very high filler content, the mixture has a yield strength, and the properties of the initial bitumen change.

Features

The surface layer depends on corrosion in the gas phase and aqueous solutions, wear (stripping), high-temperature treatment. The surface of the particles of any material (the surface layer) differs from the "deep" layers of this material. Thus, the intensity and quality of the flow of physico-chemical processes at the interface "binder - mineral powder" will be interrelated with the dispersion of the powder, which is due to the acquisition of more homogeneous properties of the surface and inner layers of particles with increased fineness of grinding.

A traditional powder with a large number of positive adsorption centers and a high structuring ability is limestone mineral powder [4]. Research has established that mineral powders obtained as a result of fine grinding of limestones and dolomites are the best. Almost all researchers who have worked in this field come to this conclusion [17,49-50,68]. Domestic and foreign experience in the construction of asphalt concrete coatings confirms the high quality of these powders. Currently, their shortage leads to the fact that powders obtained by grinding other rocks or industrial waste are used.

Depending on the nature of the mineral material and the chemical composition of bitumen, the properties of its thin layers vary differently. On an active mineral surface (limestone, dolomite, marble), the strength of bitumen in a thin layer increases with a decrease in its thickness, on an inactive mineral surface (granite, quartz), the strength of bitumen changes little with a decrease in the thickness of the layer [28,38]. At the same time, the strength of the bitumen mineral material is actually determined by the cohesion of bitumen.

Since the activity of the surface of the material is determined to a large extent by the chemical composition of bitumen [84], primarily by the presence of surfactants in its composition, which manifests itself in a linear dependence of the measure of activity on the acid number of bitumen and the content of asphaltenes in it, the activation of the surface of mineral materials by surfactants, leading to the appearance of chemoadsorption

the interaction of bitumen and the material leads to a sharp increase in the cohesion of bitumen with a decrease in the thickness of its layer [84].

One of the effective methods of increasing the adhesive activity of mineral powders in relation to organic binders is the preliminary physico-chemical activation of their surface [30]. To strengthen the connection between mineral components and organic binder, various surfactants are used in the production technology of asphalt concrete mixtures [38,77-78].

The influence of the surface of the mineral material and its activation by surfactants on the properties of bitumen in thin layers is clearly manifested in the study of the properties of bitumen-mineral materials. By changing the thickness of the bitumen layers and the properties of the surface of mineral grains, it is possible to adjust the elastic and plastic parameters of asphalt concrete, and, consequently, its most important road-building properties [92]. The influence of such powders on the properties of sandy asphalt concrete is especially significant.

Conclusion

Thus, the activation of mineral powder is at the same time the simplest and most effective way of introducing surfactants into the asphalt concrete mixture and is one of the most qualitative ways to improve the properties of asphalt concrete, which allows, with a rationally selected amount of surfactant content, to significantly expand the range of rocks used to obtain mineral powders used in road construction, as well as to introduce into the process preparation of asphalt concrete mixtures is local industrial waste.

REFERENCES

1. Andreichikova V.V., Nemchinov M.V. Ways to improve the production of cationic bitumen emulsions. Problems of the construction and road complex. - Bryansk: BGITA, 1998. - S. 33 - 38.
2. Alferov V.I. Improving the reliability of roads by building wear layers using the “Slurry Seal” method. Abstracts of reports of the international scientific-practical conference. - M.: MADI, 2000. - S.189-190.
3. Alferov V.I. Experience in the use of thin wear layer technology of the "Slurry Seal" type in the Voronezh region. Abstracts of reports of the international scientific-practical conference. Minsk: BeldorNII. - 2001.
4. Begunkova N.I. On the formation of dense mineral mixtures with emulsions I Proceedings of SoyuzdorNII, 1972, no. 57, pp. 90 - 101.
5. Gezentsvey L.B. Road asphalt. - M.: Transport, 1985.