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INVESTIGATION OF THE ADHESION PROPERTIES OF ROAD BITUMEN WITH MINERAL MATERIALS

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ABSTRACT
This paper investigates the effect of hydrated lime additive on improving the adhesion properties of 50/70 penetration grade paving bitumen with dolomite crushed stone, which is widely used in road construction. Hydrated lime was incorporated into the bitumen at concentrations of 1.0%, 1.5%, and 2.0% by weight, and the degree of adhesion between the binder and mineral aggregate was evaluated. The research results demonstrated that the addition of hydrated lime significantly enhances the adhesion between bitumen and dolomite aggregate. The best performance was observed when 1.0-1.5% hydrated lime was used.

KEYWORDS: Bitumen, hydrated lime, dolomite crushed stone, adhesion, asphalt concrete, mineral aggregate, road construction.

INTRODUCTION
In recent years, considerable attention has been paid to the modification of bitumen due to the increasing traffic volume, higher axle loads, moisture-induced damage, permanent deformations, and fatigue cracking, as well as the insufficient rheological performance of conventional bitumen under various climatic conditions [1, 2].

The service life of highway pavements largely depends on the quality of the adhesive bond between bitumen and mineral aggregates. Under the influence of moisture, the bitumen film may detach from the aggregate surface, leading to pavement deterioration and a reduction in its operational performance. Therefore, various modifiers and chemical additives are commonly used to improve the adhesion characteristics of bitumen.

One of the most effective approaches to addressing this issue is the modification of bitumen with mineral additives. Among these additives, hydrated lime has gained significant importance in road construction because it improves the adhesion between bitumen and aggregate particles, enhances moisture resistance, and reduces cracking caused by freeze–thaw cycles. In addition, hydrated lime affects the colloidal structure of bitumen, improving its rheological properties and providing better resistance to deformation at elevated temperatures [3].

Materials and Methods. In this study, 50/70 penetration grade bitumen was used as the base binder for preparing modified binder mixtures. Hydrated lime was employed as a modifying additive. Hydrated lime mainly consists of calcium hydroxide, $Ca(OH)_2$, and is produced

through the hydration of quicklime (primarily calcium oxide, CaO) using specialized hydration equipment. Quicklime is manufactured by calcining high-purity limestone (calcium carbonate, $CaCO_3$) in special kilns at temperatures of approximately 900°C [4]. The hydrated lime used in this study was obtained from a local source. Dolomite crushed stone produced at a stone-crushing plant in the Jizzakh region was used as the mineral aggregate.

Figure 1. Boil the prepared sample in water for 30 minutes.

The adhesion tests were conducted in accordance with the requirements of GOST 11508-74. The prepared bitumen–aggregate mixture was immersed in a beaker containing boiling distilled water, ensuring that the water level was maintained 40-50 mm above the sample surface. The specimens were kept in boiling water for 30 minutes. During the test, excessive boiling of the water was avoided. Any bitumen that detached from the aggregate and floated to the water surface during boiling was removed using filter paper.

Immediately after completion of the boiling process, the test specimens were transferred into beakers containing cold water and kept there for 3–5 minutes. Subsequently, the samples were removed from the water, and the adhesion of bitumen to the aggregate surface was evaluated by visually comparing the tested specimens with standard reference photographs of bitumen-aggregate mixtures.

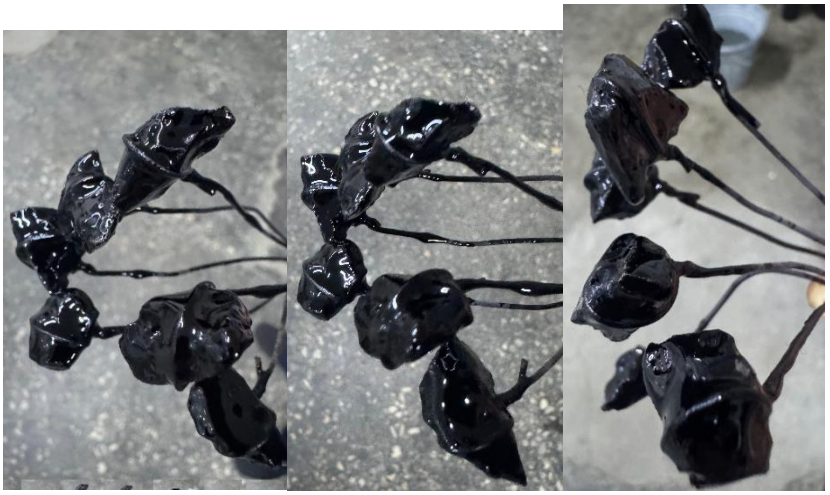

Figure 2. Binding of bitumen with inert material

Results and Discussion

The adhesion performance of the bitumen–aggregate system was evaluated in accordance with the requirements of GOST 11508-74. The study included an unmodified control sample and bitumen samples modified with hydrated lime at concentrations of 1.0%, 1.5%, and 2.0% by weight.

Examination of the control specimen after exposure to boiling water revealed partial detachment of the bitumen film from the surface of the dolomite aggregate. This observation indicates that the adhesive bond between the binder and the aggregate weakened under the influence of moisture, resulting in reduced surface coverage.

In contrast, specimens containing hydrated lime demonstrated noticeably improved adhesion characteristics. For the sample modified with 1.0% hydrated lime, a greater proportion of the aggregate surface remained coated with bitumen after testing compared with the control specimen. This improvement can be attributed to the ability of hydrated lime to enhance the chemical activity of the aggregate surface and promote stronger interactions between the binder and mineral material.

The specimens containing 1.0% and 1.5% hydrated lime exhibited the most favorable performance. Visual assessment showed that the bitumen coating remained almost completely intact on the aggregate surface following the boiling water test. The enhanced adhesion is likely associated with physicochemical interactions between hydrated lime and the polar constituents of bitumen, which strengthen the interfacial bonding forces.

A similarly high level of adhesion was observed in the specimen modified with 2.0% hydrated lime. Despite prolonged exposure to boiling water, most of the aggregate surface remained covered by the bituminous film. These findings confirm that hydrated lime contributes to improved moisture resistance and helps maintain a durable bond between bitumen and mineral aggregates.

Overall, the results clearly demonstrate that the incorporation of hydrated lime enhances the resistance of the bitumen–aggregate system to moisture-induced stripping. The modified binders showed superior adhesion behavior compared with the unmodified control mixture, indicating the effectiveness of hydrated lime as an anti-stripping additive for asphalt mixtures containing dolomite aggregate.

Conclusion

The experimental investigation confirmed that the addition of hydrated lime significantly improves the adhesive properties of paving bitumen when combined with mineral aggregates. While the unmodified control sample exhibited partial loss of bitumen coverage after exposure to boiling water, the modified mixtures retained a substantially higher degree of aggregate surface coating.

Hydrated lime contents of 1.0%, 1.5%, and 2.0% were evaluated, and all modified samples demonstrated better adhesion performance than the control specimen. The most pronounced improvement was observed in mixtures containing approximately 1.0-1.5% hydrated lime, where strong bonding between the bitumen and dolomite aggregate was maintained even under severe moisture exposure.

The findings indicate that hydrated lime is an effective mineral additive for enhancing the moisture resistance and durability of bituminous mixtures. Its incorporation improves the

stability of the bitumen–aggregate interface, reduces the likelihood of moisture-related damage, and can contribute to extending the service life of asphalt pavements.

Based on the obtained results, the use of hydrated lime in the range of 1.5-2.0% by weight of bitumen is recommended for asphalt mixtures produced with dolomite aggregates. Such modification can provide improved adhesion characteristics and increased resistance to environmental factors, thereby enhancing the long-term performance of pavement structures.

References

1. Bala, N., Napiah, M., & Kamaruddin, I. (2018). Effect of nanosilica particles on polypropylene polymer-modified asphalt mixture performance. Case Studies in Construction Materials, 8, 447–454.
2. Sadikov, I.S., & Tovboev, B.X. (2025). Additives for asphalt concrete mixtures: A review of the literature. Problems of Architecture and Construction (Scientific and Technical Journal), No. 2, Samarkand. (in Uzbek)
3. Sadikov, I.S., & Tovboyev, B.X. (2025). Investigation of the influence of hydrated lime on the physical and mechanical properties of road bitumen. JizPI Bulletin, No. 4, 169–175. (in Uzbek)
4. Sadikov, I.S., & Tovboyev, B.X. (2025). Effect of hydrated lime on road bitumen. In Proceedings of the International Scientific and Practical Conference “Current Problems and Prospects of Chemistry and Chemical Technology” (pp. 602–605), Jizzakh, Uzbekistan. (in Uzbek)
5. GOST 11505-75. (1975). Petroleum bitumen. Methods for determining the adhesion of bitumen to marble and sand. Moscow, (in Russian)