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**TOSHKENT DAVLAT  
TRANSPORT UNIVERSITETI**

Tashkent state  
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# **ENGINEER**

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**TEXNIKA FANLARI DOKTORI, PROFESSOR  
MIRAXMEDOV MAXAMADJON MIRAXMEDOVICH  
TAVALLUDINING 80 YILLIGIGA BAG'ISHLANGAN  
“SAMARALI QURILISH MATERIALLARI, KONSTRUKSIYALARI VA  
TEKNOLOGIYALARI”  
MAVZUSIDAGI XALQARO ILMIY-AMALIY KONFERENSIYASI  
ILMIY ISHLARI TO'PLAMI**

Toshkent davlat transport universiteti RAASN akademigi, O'zbekistonda xizmat ko'rsatgan yoshlar murabbiyi, texnika fanlari doktori, professor Miraxmedov Maxamadjon Miraxmedovich tavalludining 80 yilligiga bag'ishlangan, ilmiy ishlar to'plami nashr etilishi ko'zda tutilgan «Samarali qurilish materiallari, konstruksiyalari va texnologiyalari» mavzusidagi Xalqaro ilmiy-amaliy konferensiyani o'tkazishni rejalashtirmoqda.

M.M. Miraxmedov kompozitsion qurilish materiallarining polistruktura nazariyasini rivojlantirishga salmoqli hissa qo'shgan. Uning qurilish materialshunosligi sohasidagi ilmiy hissasi e'tirofi sifatida 1995-yilda Rossiya arxitektura va qurilish fanlari akademiyasining (RAASN) xorijiy a'zosi etib saylangan. M.M. Miraxmedov 6 ta monografiya, 200 dan ortiq ilmiy maqolalar va 25 ta ixtiroga mualliflik guvohnomalari muallifidir.

Ushbu konferensiyaning asosiy maqsadi - qurilish materialshunosligi, bino va inshootlarni loyihalash va qurilish sohasidagi ilmiy tadqiqotlar natijalarini, shuningdek, muhandislik ta'limini takomillashtirish yo'llarini muhokama qilishdan iborat.

Konferensiya ishida ishtirok etish uchun oliy o'quv yurtlari va ilmiy tadqiqot institutlari olimlari, O'zbekiston Respublikasi va xorijiy davlatlarning ishlab chiqarish vakillari, ilmiy tadqiqotlarda salmoqli natijalarga ega bo'lgan mutaxassislar taklif etiladi.

**“Samarali qurilish materiallari, konstruksiyalari va texnologiyalari”** mavzusidagi xalqaro ilmiy-amaliy konferensiyaning asosiy yo'nalishlari quyidagilardan iborat:

1. Resurs va energiya tejovchi qurilish materiallari va texnologiyalari.
2. Atrof-muhitning transport infratuzilmasiga ta'siri va uni himoya qilish usullari.
3. Bino va inshootlarning qurilish konstruksiyalari: hisoblash va loyihalashning zamonaviy usullari.
4. Arxitektura, shaharsozlik va shahar muhitini rivojlantirish.
5. Qurilishni tashkil etishning innovatsion usullari va qurilish jarayonlari texnologiyalari.
6. Transport obyektlarini loyihalash va qurishda raqamli texnologiyalar hamda sun'iy intellekt.
7. Temir yo'l transporti infratuzilmasi obyektlarini loyihalash, qurish va ekspluatatsiya qilish.
8. Zamonaviy muhandislik ta'limi tizimini takomillashtirish.

Mazkur konferensiya ilmiy hamjamiyatning turli vakillarini bir joyga jamlab, qurilish materialshunosligi sohasidagi zamonaviy muammolar va istiqbollarni muhokama qilish uchun qulay platforma vazifasini bajardi.

# Visual Determination of Adhesion of Bitum Modified with Defecate with Marble Stone

I.S. Sadikov<sup>1</sup><sup>a</sup>, G.K. Isakova<sup>1</sup><sup>b</sup>, R.K. Kadirbergenov<sup>1</sup><sup>c</sup>

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**Abstract** The longevity of asphalt concrete pavements largely depends on the adhesion properties between bitumen and mineral aggregates. The insufficient adhesion of the bitumen to the surface of the unit leads to coating degradation under the influence of moisture, a decrease in strength, and a reduction in service life. Therefore, improving the adhesive properties of bitumen is one of the important issues in the field of road construction. In this article, the adhesion properties of grade 50/70 road bitumen to marble stone material were studied by modifying it with defective mineral powder, which is a sugar refinery waste. During the research, a homogeneous mixture was prepared by adding a certain amount of defecate to the bitumen composition, and visual tests were conducted in accordance with the requirements of GOST 12801. During the test, the degree of bitumen retention on the marble surface was assessed through visual observation.

**Keywords:** Road bitumen, defect, adhesion, modification, marble stone, industrial waste

## 1. INTRODUCTION

Bitumen binder is the primary adhesive material for road surfaces, which holds the road structure in a continuous state and makes the surface of the coating waterproof. However, when cracks appear in the pavement or water enters the pavement from the external environment, the connection between the bitumen and the aggregate is disrupted, and the bitumen separates from the surface of the aggregate [1].

By their chemical nature, aggregates can be acidic or basic (alkaline). According to Hefer's (2005) research, acidic materials form better chemical bonds with basic materials, and basic materials with acidic materials. To form a strong chemical bond in the bitumen-aggregate system, a base aggregate such as limestone reacts well with the acidic components contained in the bitumen [2]. Calcium carbonate ( $\text{CaCO}_3$ ), present in limestone, forms a strong bond with the carboxylic acids in the bitumen. Conversely, silicate aggregates have an acidic nature, and bitumen is also a weakly acidic substance. Therefore, the adhesion strength between such aggregates and bitumen is relatively low [3]. Nevertheless, under high temperatures and mechanical effects, a certain degree of bonding between the bitumen and the aggregates can occur. However, when water enters the asphalt surface, it displaces the bitumen film from the surface of the unit. Once this process begins, separation accelerates[4].

Currently, scientific research is being conducted to improve the physical, mechanical, and adhesive properties of bitumen to increase the service life of

highway pavements. The efficient use of industrial waste is particularly important from both environmental and economic perspectives [6]. One of the wastes generated in sugar production plants is defecate, which contains calcium carbonate, organic substances, and fine mineral particles. The use of this material as a bitumen modifier allows for the improvement of asphalt concrete composition.

The adhesion of bitumen to mineral material determines the water resistance and strength of the asphalt concrete. According to GOST 12801, adhesion is determined by evaluating the visual condition of the surface of the bitumen-coated stone material.[5]

The aim of this study is to visually evaluate the adhesion properties of grade 50/70 bitumen with marble stone by modifying it with a 5% defect.


## 2. RESEARCH METHODOLOGY

In this experiment, 50/70 bitumen, widely used in road construction, was selected as the bitumen binder, and one of the wastes generated at sugar production enterprises—defecate—was obtained. The nature of the chemical composition of the selected mineral powder was analyzed separately (Table 1). Table 1. Chemical composition of the defect.

**Table 1**  
**Chemical composition of the defect**

Component	Amount (%)
N(Nitrogen)	0.2–0.7
$\text{P}_2\text{O}_5$ (Phosphorus)	0.2–0.9
$\text{K}_2\text{O}$ (Potassium)	0.3–1.0

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MgO (Magnesium)	0.4–0.8
CaCO <sub>3</sub>	80-85

Marble grain (at least 10 mm) is tied to it with a thread or thin wire (diameter not more than 0.5 mm) and heated in a drying oven. The heating temperature of the crushed stone is 130–150°C for viscous bitumens (Fig. 1). After 1 hour of heating, it is immersed in bitumen for 15 seconds, then removed and hung on a stand to drain excess bitumen. The marble stone sample was covered with bitumen with a defect of 5% relative to the mass of the prepared bitumen (Fig. 2). The samples were tested in a hot water environment in accordance with the requirements of GOST 12801. Then it is removed and immersed in a glass of cold distilled water for 1-3 minutes to cool and fix the bitumen film remaining on the surface of the gravel. The surface of the marble grain is checked on a 5-point scale with an interval of 0.5 points. After testing, the sample surface was visually evaluated according to Table 2.



Fig. 1.



Fig. 2.



Fig. 3.

**Table 2**  
The results are evaluated according to the table below

Properties of bitumen film on the surface of gravel	Quality
The film is fully preserved, although its thickness may decrease in some places.	5 points (very good)
The film is intact, but has been partially detached from sharp corners and edges.	4 points (good)
More than 50 percent of the film remains on the surface of the stone.	3 points (satisfactory)
The film is preserved by less than 50 percent, and individual drops of bitumen are observed on the exposed surface.	2 points (bad)

### 3. RESULTS AND DISCUSSION

The results of the laboratory tests conducted show that the adhesion properties of bitumen modified on the basis of defecate (sugar production waste) to the surface of mineral materials, particularly marble, are significantly higher than those of conventional bitumen.

During observations, it was established that the interaction between the modified bitumen and the marble stone is stable and durable. The active components in the defecate have a positive effect on the physicochemical properties of the bitumen, increasing its polarity and, as a result, contributing to the formation of a strong molecular bond on the surface of the mineral material. Under hydrothermal and mechanical loads, the main part of the binder layer remains intact. This indicates that the process of the binder's separation from the mineral surface occurs to a very small extent [7]. The experimental results also confirmed that almost the entire surface of the mineral material is covered with bitumen. Only in some cases were very small point



separations observed in microzones with sharp edges and high surface energy of the crystalline structure. Based on the results of visual assessment and current standard requirements, it was established that the degree of adhesion of the modified bitumen has high quality indicators. It can be evaluated as an effective material in ensuring the strength and longevity of road surfaces, showing significantly superior results compared to conventional bitumen. Overall, while cases of binder separation are more common in conventional bitumen samples, defect-modified bitumen demonstrated a high degree of adhesive stability and reliability.

The indicators obtained during the study confirm that incorporating the defecate into the bitumen composition allows for a fundamental improvement in the physical, mechanical, and adhesive properties of the binder. Primarily, this is explained by the fact that highly dispersed mineral particles in the defecate function as active fillers within the bitumen dispersion system. In this process, fine dispersed particles strengthen the molecular structure of the bitumen, forming a stable framework in the "bitumen-filler" system, which in turn increases the ability of the binder to moisten the surface of the mineral material.

At the same time, calcium compounds and other active components in the defecate chemically interact with the asphaltene and resin fractions of the bitumen, ensuring thermodynamic stability in the boundary layer between the mineral material and the binder. As a result of such a complex action, the water resistance of the asphalt concrete pavement increases, and the risk of bitumen film detachment during operation is significantly reduced.

From an economic and environmental perspective, the use of industrial waste defecate as a modifier serves as an effective alternative to expensive artificial additives while optimizing the consumption of pure bitumen. Most importantly, this method of disposal creates a foundation for mitigating the negative impact of sugar industry waste on the environment and developing waste-free technologies based on the principles of the "green economy." In conclusion, composite materials based on defecate-modified bitumen are a promising direction in road construction, ensuring high operational efficiency.

#### 4. CONCLUSION

As a result of scientific research and laboratory tests, it was confirmed that adding a 5% defecate additive to grade 50/70 bitumen significantly strengthens the adhesive bond of the binder with the marble mineral material. Visual and instrumental assessments conducted in accordance with the requirements of GOST 12801 showed that the modified bitumen

possesses high quality indicators and is included in the highest scoring system [5]. This modification method serves as an effective technical solution for increasing the resistance of asphalt concrete coatings to water and aggressive environmental influences. At the same time, the application of defecate, which is considered a sugar industry waste, in the field of road construction is of strategic importance in the rational disposal of industrial waste and ensuring environmental sustainability. General analyses indicate that the developed modified bitumen composition allows for the extension of road pavement service life and the achievement of economic efficiency[9].

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