STUDY OF THE DISADVANTAGES OF ASPHALT CONCRETE PAVEMENTS IN HOT CLIMATES

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Abstract*. This article provides information about the disadvantages of asphalt concrete pavements in hot climates. Asphalt concrete pavement is a more durable coating for hot climates. The reason for this is that the raw bitumen contained in the asphalt concrete mixture softens at lower temperatures during the summer season. In addition, this article provides information on wheel track deformations on asphalt concrete pavements. To prevent these shortcomings, scientific research is being conducted to increase the softening temperature of bitumen in an asphalt concrete mixture by introducing additives into the bitumen composition.*
Keywords*: asphalt concrete, bitumen, ruts, coatings.*

Asphalt concrete, also known as asphalt pavement, is a composite material commonly used in construction of roads, highways, and parking lots. It is made up of mineral aggregate bound together with asphalt, which is a sticky, black, and highly viscous liquid or semi-solid form of petroleum. Asphalt concrete is popular for its durability, smoothness, and ability to withstand heavy loads and adverse weather conditions.

Asphalt concrete is a building material consisting of crushed stone, sand, mineral powder and bitumen mixture. Before mixing, they are heated to a temperature of 150-180 °C. Hot asphalt concrete, laid and compacted at a temperature not lower than 120 °C, warm low-viscosity asphalt concrete, compacted at a temperature of 40-80 °C, cold asphalt concrete with liquid bitumen, compacted at air temperature (above 5 °C). It is divided into coarse, medium, fine-grained and sandy asphalt concrete [1].

Disadvantages of asphalt concrete pavement:

- the air temperature during installation should not be lower than 5 °C;
- resistant to hot weather conditions;
- Low level of development of the bitumen industry in Uzbekistan;
- durability and other factors;
- cracks in the cold;
- formation of transverse irregularities under the influence of weight;
- asphalt pavement can soften in extremely hot weather and become brittle and prone to cracking in very cold weather.

Maintenance requirements: Regular maintenance, such as sealing cracks and resealing the surface, is required to prolong the lifespan of asphalt pavement.

Environmental impact: The production of asphalt concrete requires significant energy and emits greenhouse gases. Also, asphalt pavement contributes to the urban heat island effect, as it absorbs and retains heat.

Durability issues: Although durable, asphalt pavement can deteriorate over time due to factors such as heavy traffic, moisture penetration, and exposure to chemicals.

Shorter lifespan compared to concrete: While asphalt concrete is durable, it generally has a shorter lifespan compared to concrete pavement, especially in areas with heavy traffic and harsh weather conditions.

Maintenance cost: While maintenance is necessary for both asphalt and concrete pavements, the cost of maintaining asphalt pavement can be higher due to the need for more frequent repairs and resurfacing.

There have been numerous scientific studies conducted on the disadvantages of asphalt concrete. These studies typically focus on various aspects such as durability, environmental impact, maintenance requirements, and long-term performance. Here are a few examples of scientific studies on the disadvantages of asphalt concrete:

- “Environmental Impact and Benefit Assessment of Asphalt Concrete Pavements”. This study, published in the Journal Environmental Engineering, evaluates the environmental impact of asphalt concrete pavements, including their contribution to greenhouse gas emissions, energy consumption, and potential for recycling [2].

- “Evaluation of Cracking in Asphalt Concrete Overlays of Jointed Concrete Pavements”. Published in the Transportation Research Record: Journal of the Transportation Research Board, this study investigates the causes of cracking in asphalt concrete overlays of jointed concrete pavements and proposes strategies for mitigating these issues.

These are just a few examples, but there are many scientific studies that discuss the disadvantages of asphalt concrete and potential solutions to mitigate these problems.

In the conditions of Uzbekistan, the construction of asphalt concrete pavements is quite expensive from an economic point of view. In addition, in hot climates, asphalt concrete pavements melt from the heat, causing lateral disturbances when heavy vehicles move. Another important reason is the high cost of bitumen in asphalt concrete. In addition, roads, even after commissioning, are not in use for a long time.

Asphalt concrete roads have a number of problems in hot climates. Despite the strength of road base materials and asphalt concrete pavement layers, the formation of wheel track deformation is disrupted when vehicle wheels impact the top layer of asphalt concrete pavements. In real conditions, these processes lead to the formation of wheel tracks [3].

Figure 1. Cracks on roads in hot climates.

Figure 2. Emergence of intersectional violence in warm climates.

The formation of wheel track deformation on highways is influenced by two main factors.

- influence of weather and climatic conditions;
- the impact of loads falling from cars;

The influence of climatic factors on the formation of wheel tracks. High air temperature has a direct impact on the formation of wheel marks. The dependence of the wheel track deformation depth on the air temperature and the number of heavy vehicles passing along one track is expressed by the following mathematical model [4]:

$$h_k = a * N^b * T^Q \quad (1)$$

Here: N- number of heavy-duty transport passes, vehicles/day;

T– temperature of asphalt concrete pavement, °C;

b– load increase factor;

a and Q– coefficient of dependence of the shape of asphalt concrete pavement.

The greatest rutting deformation is observed on pavements consisting of unhardened asphalt concrete and other bitumen-mineral mixtures, and on roads with cement concrete pavements it can only form due to erosion.

In recent years, the problem of combating wheel track deformation has been considered the most important task of public roads of the Republic of Uzbekistan. This is due to the fact that part of the traffic flow is an increase in the proportion of heavy multi-axle vehicles, which accelerates the process of rutting on roads and accelerates the occurrence of rutting in hot climates. In hot climates, wheel ruts make it difficult for vehicles to move, and when overtaking, the driver loses balance, which leads to a decrease in speed and a traffic accident.

Sections of roads with a rut depth exceeding the maximum permissible value are considered dangerous for vehicle traffic, and work to eliminate the ruts is required immediately.

Parts of the wheel tracks, the depth of which exceeds the maximum allowable clearance values. First of all, you need to work on getting out of the rut.

The formation of wheel track deformation on roads is observed more in the southern region than in the northern region of the Republic of Uzbekistan. Therefore, it is necessary to study the influence of climatic factors on asphalt concrete pavements of highways.

The current recommended design temperature for assessing pavement strength (MQN 46-08) is 10 °C. The solution to this problem is carried out in two stages: studies are carried out of the influence of only temperature and at the same time the influence of air temperature and loads from vehicles [5].

Determination of the temperature dependence of the appearance of wheel tracks on asphalt concrete pavement and prediction of the appearance of wheel tracks depending on changes in air temperature.

Despite these disadvantages, asphalt concrete remains a popular choice for road construction due to its initial lower cost, ease of installation, and ability to be recycled. However, it's essential to weigh these disadvantages against the specific needs and conditions of the project before choosing asphalt concrete as a paving material.

To address the disadvantages of asphalt concrete and prevent defects, several measures and advancements are being implemented in the construction and maintenance of asphalt pavements. Some of these measures include:

Improved Mix Designs:

Advances in asphalt mix designs have led to the development of modified asphalt binders and mixtures that offer better resistance to cracking, rutting, and moisture damage.

Use of Additives and Modifiers:

Additives such as polymers, fibers, and recycled materials are being incorporated into asphalt mixtures to enhance their performance and durability.

Polymer-modified binders improve resistance to rutting and cracking, while fibers help prevent cracking and increase tensile strength.

Warm Mix Asphalt (WMA):

WMA technologies allow for the production and placement of asphalt mixtures at lower temperatures compared to traditional hot mix asphalt (HMA), resulting in reduced energy consumption, lower emissions, and improved workability.

High-Performance thin Overlays:

High-performance thin overlays (HPTO) are thin layers of asphalt mix applied over existing pavement surfaces to improve ride quality, prevent surface distress, and extend the life of the pavement.

Pavement Preservation Techniques:

Various pavement preservation techniques, such as crack sealing, chip sealing, and microsurfacing, are used to prevent the development of cracks, minimize water infiltration, and extend the service life of asphalt pavements.

Innovative Construction Technologies:

Advancements in construction technologies, such as intelligent compaction, infrared asphalt repair, and automated paving systems, help improve the quality and uniformity of asphalt pavements, reducing the risk of defects and premature failure.

Research and Development:

Ongoing research and development efforts focus on understanding the underlying mechanisms of pavement distress, developing innovative materials and technologies, and improving pavement design and construction practices.

These measures, along with regular inspection, maintenance and restoration, help to minimize defects and maximize the performance and service life of asphalt concrete pavements. In addition, the introduction of environmentally friendly methods, such as the use of recycled materials and energy-efficient production technologies, helps to reduce the environmental impact of asphalt pavement construction and maintenance.

To summarize, today's conventional asphalt concrete changes its condition in hot climates. To prevent this from happening, it is advisable to use asphalt concrete prepared using modified bitumen using modern technologies. This ensures the resistance of the asphalt concrete pavement to high temperatures.

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