Technology and principles of asphalt paving

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Abstract. The use of high quality equipment in the construction of asphalt pavements is one of the ways to get financial profit from the further use of the developed roadbed. Taking into account the peculiarities of delivery of asphalt mixture to the object of construction, its storage, moving into the hopper of the paver, can significantly reduce the phenomenon of segregation of the mixture, both fractional and temperature. Attention paid to the process of surface formation by the paver, docking with arriving dump trucks, prevents the appearance of defects in the laid layer: joints, potholes, irregularities. The analysis of negative phenomena that may arise in the technology of paving, made by the authors, gives the reader an opportunity to understand how technologically precise the process of building roads should be.

1. Introduction

The topics related to the paving of asphalt concrete mixtures are the most relevant in countries with developing road infrastructure. Such countries include the Russian Federation, Canada, Australia. Paving asphalt mixture is not only the working principles of the paver, but also the planning of works, solving the logistical problems, overloading, pre-compaction, fractional and temperature-related segregation.

2. Problems of laying asphalt concrete mixture

The main task of an asphalt paver is to form a layer of asphalt mixture according to the technical specification on the thickness of the layer, texture, smoothness and surface profile.

During the paving operation, it is important to ensure that the four basic criteria are met: mixture tonnage, paving width and thickness, control of parameters.

One of the problems of laying is to ensure the continuous delivery of the mixture to the construction site. This is affected by the productivity of the asphalt plant, the asphalt mixture transport routes, road conditions and the number of dump trucks available.

Asphalt plants can have different output volumes. The main task is to find out how many dump trucks it will take to ensure the constant availability of the mixture in the hopper of a working asphalt paver, taking into account the lack of equipment downtime.

In case of incorrect calculations or other factors, such as equipment failure, there will be a problem with the lack of asphalt mixture. In this case, it will be necessary to increase the time of paving the existing volume of the mixture, either by reducing the speed of paving, or be forced to stop the work in an emergency situation. But the stoppage should occur only when the hopper is filled with the mixture, this is done in order to preserve the temperature of the contact zone in which the next layers of the mixture are connected, otherwise, when the paver stops, a seam is formed (Fig. 1).
To minimize the formation of seams, an efficient paving mode is used, which uses the next cycle:
1- Paving of a certain length of road;
2- Paver stoppage;
3- Pausing for the maximum time interval, which will not lead to cooling of the mixture;
4- Paving the next length of road.
This mode of operation is maintained until a dump truck with asphalt mixture arrives or until the mixture is finished.

The second unfavourable option is the overabundance of dump trucks. In this case, the problem of the asphalt mixture cooling also occurs. The duration of dump truck downtime with the mixture inside is influenced by weather factors, which significantly reduce the temperature of the mixture: rain, snow and cold weather [3].

Permissible transport range depends on the type of mixture, climatic conditions, the state of the delivery routes to the jobsite. The temperature of hot asphalt mixture at delivery should be within 115 - 155 °C. For indicative calculations, it is considered that the mixture cools down by 1 °C for each kilometer of the way or 20 °C for each hour of the way. Based on experience, in dry hot weather, hot mixture can be transported up to 40 ... 50 km, and in cool weather - up to 20 ... 30 km.

An important problem associated with the delivery of the mixture is segregation, which can be of two types (Fig. 2.):
- Temperature segregation
- Fractional segregation

Fractional segregation of the mixture is a change in the particle size distribution of aggregates and a change in the binder content in the originally homogeneous asphalt mixture due to separate movements
of particles of coarse and fine aggregate in the process of working with the mixture. In the process of transporting the dump trucks move on uneven surfaces, in urban traffic constant braking and acceleration lead to vibration in the body of the dump truck. Denser particles such as gravel, crushed stone, fall to the bottom, and lighter particles such as bitumen rise to the top. Mixture in which segregation has occurred needs to be mixed because if you pave with such a mixture, the entire asphalt surface will be heterogeneous, because the lighter particles will be on top of the entire mixture and they will get to the hopper of the paver first. As a result of paving, the mixture will be very fine at first, but with each meter of coating, the granules will become larger and larger.

Temperature segregation is the uneven temperature distribution of the mixture over its volume. When paving the mixture, it is necessary to achieve temperature uniformity, because if the mixture cools down earlier, compaction with a roller will not be effective.

To solve the problem of segregation special loaders are used, these machines are used only on large volumes of work, as they are quite expensive.

3. Asphalt paving planning
Paving parameters: width, length, thickness. Based on these parameters, the volume of mixture per square meter is determined. The thickness of the layer to be paved is adjusted with the paver's slab, and it is attached to a rocker, which is held on two hinges on each side of the machine. A hydraulic cylinder is attached to each hinge and they adjust the thickness of the layer and the angle of attack when paving the mixture.

![Asphalt paver: 1-hydraulic cylinder for tamping plate angle adjustment; 2-hydraulic cylinder for tamping plate lifting and lowering](image)

**Figure 3.** Asphalt paver: 1-hydraulic cylinder for tamping plate angle adjustment; 2-hydraulic cylinder for tamping plate lifting and lowering

Hydraulic cylinders 1 and 2 are responsible for the plate height above the surface and the angle of attack. When hydraulic cylinders 1 and 2 work in parallel, the lifting of the plate above the surface is adjusted, when one of the hydraulic cylinders is adjusted, the angle of attack is adjusted.

The angle of attack is the angle that determines the change in thickness of the layer to be laid. Usually, the angle of attack is 3-6 mm (Fig. 4).
Because the plate is a very massive, strong stresses can occur on the paver during transport on the rocker arm. Retractable rods are used on which the rocker arm is lowered to relieve the load from hydraulic cylinders and the entire structure (Fig. 5).

The paving length is determined by the distance that the paver has passed. In contrast to the thickness, the width of the layer is continuously adjustable, as it is necessary to bypass different barriers. There are two consoles installed on the paver's slab, which are responsible for its control; the consoles regulate the screws, the height of the slab's elevation, the angles of attack and the paving width. Paving in difficult places requires two operators on the right and left sides of the machine, each of them is responsible for the left and right sides respectively. The paving width of the mix can be adjusted using the joystick at the bottom of the control panel.

The standard paving widths are 2 - 4.5 meters. At the maximum paving width, screw extensions must be used, which are attached mechanically to ensure that the mixture is distributed over the entire width of the intended paving strip.

The next step is to determine the method of tracking the thickness and direction of travel, using sensors, the simplest of which is the tensioned stringline. Nowadays, both sound and light rangefinders are used; setting up the sensors of these devices is one of the most difficult stages. To improve the paving accuracy, the number of sensors installed on the left and right sides of the special supports is usually increased. When installing a large number of sensors also use a rod, which is usually attached to the sensor on the edges and center, all these measures are aimed at improving the accuracy of the paving.

4. Material feed system
The material feed system consists of a hopper, feeders, distributors and material feed sensors (Fig. 6).
The hopper plays the role of a storage for the mixture, its main property is to increase the cooling time of the mixture, the feed comes from chute conveyors, they are designed to move the mixture from the hopper to the screws. The spreader is a screw and is responsible for distributing the mixture over the width of the layer to be paved.

![Figure 6. Mixture feeding system](image)

Feed sensors are responsible for controlling the amount of mixture fed to the plate.
Also, on the front side of the paver, in front of the hopper, there are two iron rollers designed to dock the paver to the dump truck.
To ensure the smoothness of the layer to be paved, you must ensure continuous operation of the paver. Any stoppages or impacts may affect the smoothness of the paved surface.
An unfavorable point at which a stop or impact can occur is the discharge of the mixture from the dump truck into the paver's hopper. If the unloading technology is wrong, the impact will occur because most drivers will reverse at high speed until they dock with the paver. This impact causes the paver to oscillate, which in turn causes a seam to form on the paved surface.
The correct method of paving - when the dump truck stops at a short distance from the paver and turns on a neutral gear, and the paver itself approaches the dump truck and starts pushing it. Only at this moment the mix should be unloaded from the dump truck. The paver pushes the dump truck until the mixture in the dump truck body is finished. The first dump truck drives off and the full truck arrives.

5. Conclusion
Asphalt paving is one of the most expensive and technically demanding works, which requires qualified personnel. Savings on repairs and maintenance of the road network can reduce costs by up to 20 percent. Compliance with all the rules of paving technology will reduce the cost of further operation of the road by another 10-15 percent. Analysis of undesirable phenomena arising in the process of paving asphalt concrete pavement with the help of asphalt paver is one of the ways to form a rational approach in road construction.

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