METHODS OF INCREASING THE CRACK RESISTANCE OF ROAD SURFACES.

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Abstract: *The widespread use of asphalt concrete as a road-building material is due to its uniqueness, but the high dependence of its physical and mechanical properties on temperature leads to the formation of various defects on the surface, including ruts in hot periods and the most typical defect of cracks at low temperatures. Moreover, an important problem still remains unresolved - increasing the service life of repaired road surfaces and reducing the costs of their maintenance. There are several methods to solve this problem, which are listed in this article.*

Key words: *asphalt concrete, cracks, road surface, traffic flow, temperature, deformation.*

Introduction. Temperature cracks appear due to the occurrence of tensile stresses during cooling of the coating, the magnitude of which mainly depends on the coefficient of linear expansion, the magnitude of the temperature difference, the elastic modulus of the material, Poisson's ratio, and the relaxation modulus of the material over the calculation period.

Reflected cracks arise as a result of stress concentration in asphalt concrete in the area of existing seams and cracks in the base during vertical and horizontal movement of the edges of the seams and cracks.

Power cracks appear due to the occurrence of stresses from the action of transport loads with insufficient bearing capacity of the base or insufficient bending strength of asphalt concrete.

Technological cracks arise as a result of incorrect selection of the composition of the asphalt concrete mixture, violation of the technology for constructing structural layers and compaction of the mixture, as well as at the junctions of adjacent strips of asphalt concrete pavement.

Fatigue cracks arise predominantly in the form of transverse cracks on the lower surface of the road surface due to deflection of the layers of road pavement, then within 6–12 years, depending on traffic intensity and climatic factors, they grow through the entire thickness of the road surface, and can also develop from the surface of the road surface downwards.

Experience shows that it is difficult to completely avoid the formation of cracks in road surfaces. This process is associated with the influence of transport loads, temperature changes from positive to negative, the presence of cracks and seams in the underlying layers, weak foundations, and differences in the thermophysical properties of materials in adjacent layers. Moreover, due to a decrease in the plasticity of bitumen and the accumulation of fatigue damage in the climatic conditions of the Republic of Uzbekistan, it is not possible to avoid temperature cracks after 5–6 years of operation

There are several known directions for ensuring the crack resistance of asphalt concrete pavements, the main ones at the project stage are materials science (related to improving the properties of asphalt concrete to absorb tensile stresses) and structural technology (based on the choice of an effective design solution).

Material and metohods. To ensure the necessary deformability of asphalt concrete, it is proposed to reduce the viscosity of bitumen at low temperatures, change the content of crushed stone, modify the bitumen by introducing polymers, adjust the relaxation modulus and other parameters of the material that affect the formation of cracks. There is also known experience in using asphalt concrete

with the addition of rubber obtained from recycling old car tires, as well as inclusions of certain types of mineral materials (stone, glass) or organic (cellulose) fibers, acting as micro-reinforcement and stabilizer.

When regulating the properties of asphalt concrete, it is necessary to take into account that an increase in bitumen viscosity leads to a decrease in temperature crack resistance. In this case, the change in viscosity is adjusted by the amount of binder.

Mixtures with a higher bitumen content have proven themselves in terms of increasing resistance to the formation of reflected and fatigue cracks, which at the same time can lead to rutting deformations in the summer. Consequently, when deciding on a particular change in the composition of the mixture, it is necessary to take into account many factors, including the nature of crack formation, weather and climatic conditions, and the area of highway construction.

There are a large number of design solutions to combat cracking. Among them, the main ones can be considered the following:

• installation of layers of geotextiles and reinforcing geogrids and fiberglass when reinforcing new layers of coating to prevent the occurrence of reflected cracks, reinforcement when widening the roadway, etc., provided that the crack opening width is no more than 1–3 mm without deformations and irregularities at the edges or with chipped edges (figure 1);

• arrangement of layers of polymer-bitumen binder (membrane) material (figure 2);

• use of steel reinforcing mesh for optimal load distribution;

• partial or complete milling of the old coating;

• installation of local crack-breaking layers 10–50 cm wide;

• arrangement of organized cracks (expansion joints) in the asphalt concrete pavement during repair of the asphalt or cement concrete base;

• vibration destruction of old cement concrete pavement followed by installation of asphalt concrete pavement.

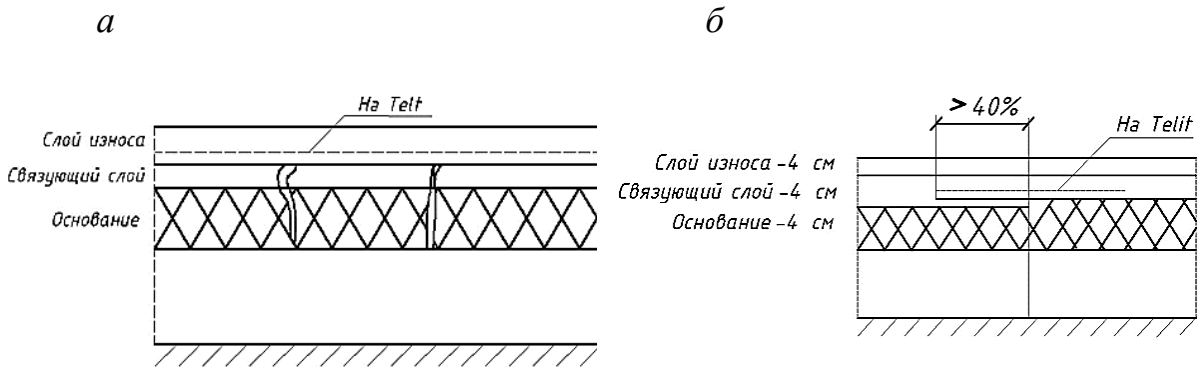


Figure 1. **Scheme of road surface reinforcement with HaTelit geogrids:**

a – reinforcement of new coating layers to prevent the occurrence of reflected cracks;

b – reinforcement when widening the roadway.

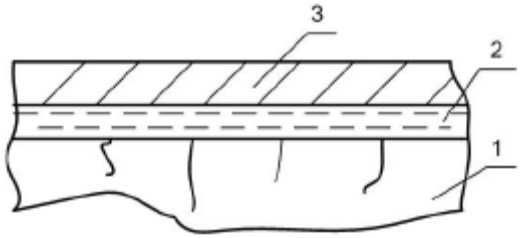


Figure 2. **Design of road pavement using Bicomplex technology:**

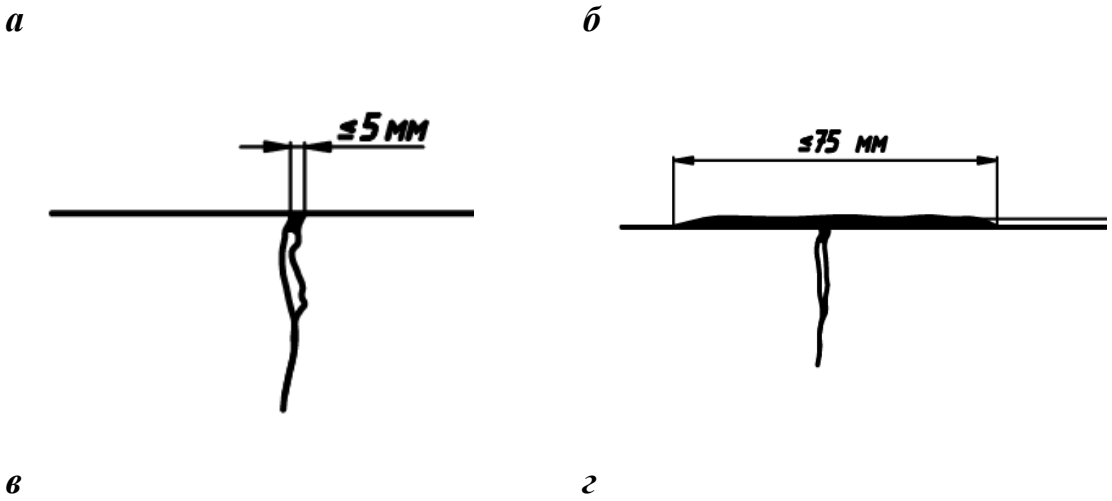
1 – base with cracks; 2 – layer of sand mixture treated with binder, thickness – 2 cm; 3 – layer of Compoflex mixture (modifiedasphalt-concrete mixture), thickness – 3 cm.

Timely repair and elimination of cracks is an important task also at the operational stage. The main condition for the correct purpose of the repair method is the determination of the causes of crack formation, the degree of destruction of the base and coating materials, a reasonable choice of time for repair work and the economic feasibility of the cost of repair work.

Repair of cracks is usually carried out in spring and autumn, when they have a significant opening. Work is carried out on a dry surface, in dry weather at an air temperature of at least 5 °C. Cracks in asphalt concrete pavements can be dealt with by sealing without cutting the crack, as well as by cutting cracks and then filling them with a mineral mixture or bitumen-polymer binder. In the presence of reflected cracks with vertical movements of the slabs, as well as power cracks in the form of a network of cracks, it is planned to replace the destroyed structural layers of the road pavement and install reinforcement layers (Figure 3).

Sealing of cracks with cold-applied materials should be done without cutting cracks with their opening width up to 5 mm (figure 3a,b). The design of methods for sealing cracks with hot-applied materials should be taken depending on the type of cracks and the degree of destruction of the crack edges.

Cracks with an opening width of 5–15 mm should be cut to a width equal to the destruction width of the crack edges, but not less than 10 mm and not more than 20 mm (Figure 3a-d). The ratio of the width of the crack groove to its depth should be from 1:1 to 1:2. If there is a protective layer (wear layer) on the asphalt concrete pavement, the depth of crack cutting should be increased by the thickness of the protective layer (wear layer).



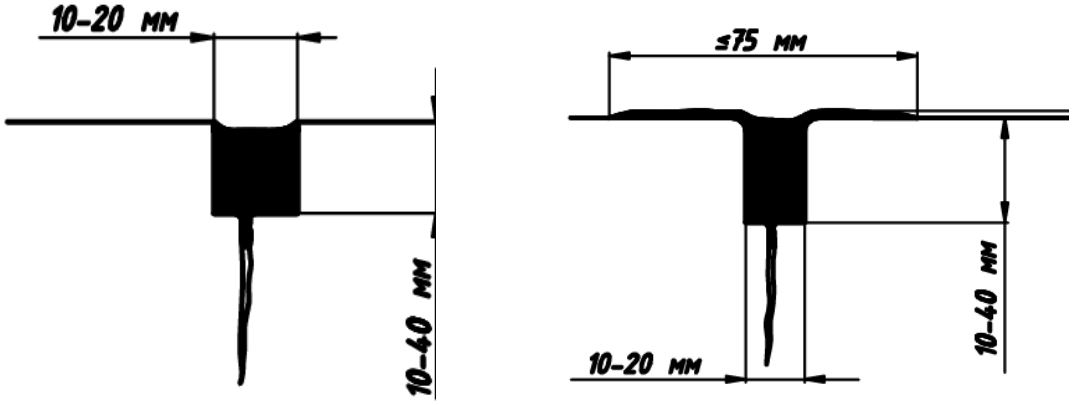


Figure 3. **Design of crack sealing methods:**

a – sealing of cracks without cutting into a coated level without installing a protective layer; b – sealing of cracks without cutting with the installation of a protective layer;

c – sealing split cracks into a coated level without installing a protective layer; d – sealing of split cracks with the installation of a protective layer

For small crack opening widths (0.5–1.0 cm), modified bitumen emulsion (EBKM-B-65), liquid bitumen, bitumen-elastomer mastic (MGBE T-65), and rubber bitumen mastic (TU BY 102307985) are used as sealants.) followed by sprinkling with friction material. For larger openings, bitumen-polymer sealant is used. The friction material used is sand from rock crushing screenings with a grain size of 2.0–4.0 (2.5–5.0) mm, separated activated sand from rock crushing screenings with a grain size of 2.5–5.0 mm, granite chips with a grain size of 2.5–5.0 mm, crushed rubber. In the case of repair of reflected and force cracks with a significant opening width, cast asphalt concrete and crushed stone-mastic asphalt concrete mixtures are used as a sealing material.

The following equipment and devices are used to seal cracks:

• filling boilers equipped with a thermostatic control system, an oil heating system, a recirculation pump and a flexible hose for filling cracks;

• impact milling machines for cutting cracks and seam cutters, providing the ability to adjust the width of the groove to be made 10–20 mm and the depth of the groove 10–40 mm;

• high-pressure water jet units providing pressure up to 20 MPa;

• compressors with a capacity of at least 5 m3/min, with a compressed air pressure of at least 0.5 MPa with effective oil and water purification systems; • hot air devices operating in conjunction with a compressor and ensuring the air temperature at the outlet of the burner nozzle is 180–250 °C; • steel applicators for filling cracks and installing a protective layer with the required geometric parameters.

To secure the repair material in the cracks, you can seal the crack with geotextile material 8–12 cm wide (figure 4). This method is applicable when sealing narrow and medium cracks. Experience shows that there is a fourfold increase in the service life of sealing cracks compared to conventional filling with repair material.

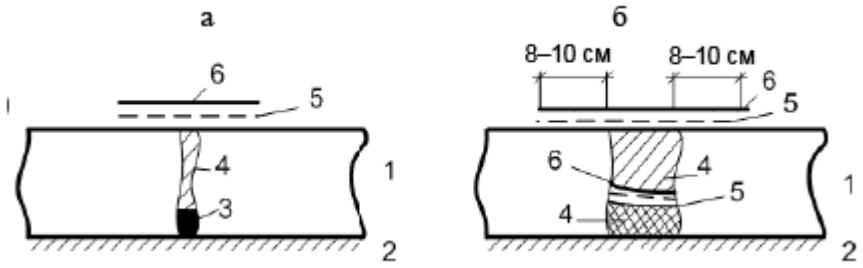


Figure 4. **Fastening the repair material with geotextile tapes:**

a – narrow and medium cracks; b – wide and very wide cracks; 1 – coating; 2 – base; 3 – remains of dust, sand, crushed stone; 4 – repair material

for filling cracks; 5 – bitumen.

In places where several cracks are located nearby or a network of cracks has formed, surface treatment is carried out over the entire area. This technology is widely used in France and a number of other countries. The advantage of crack repair technology using surface treatment is the absence of manual labor, high productivity and efficiency. It is most advisable to use this technology for repairing small cracks at an early stage of their development, which helps prevent the formation of potholes, i.e., practically avoiding the need for pothole repair.

To eliminate cracking, it is also possible to make a fundamental decision after 3–4 years of operation to cut compression expansion joints in the asphalt concrete pavement in the same way as cement concrete.

Conclusion. The fight against cracking in road surfaces is a current trend in world practice. The use of effective methods for eliminating cracks would increase the service life of coatings and reduce the costs of their maintenance and repair. Much work has been done by scientists both to improve the compositions of asphalt concrete in order to prevent the appearance of temperature and fatigue cracks, and to develop structural and technological measures (mainly to solve the problem of the occurrence of reflected cracks in asphalt concrete reinforcement layers).

Existing technologies for sealing cracks in road surfaces at the operational stage make it possible to eliminate cracks quite effectively, depending on their nature and opening width. However, it is necessary to develop a system for diagnosing and combating cracks with an opening width of up to 2 mm in order to prevent their further development, leading to serious damage to the top layer of the road surface.

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