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ON THE ISSUE OF REPAIR TECHNIQUE OF ASPHALT PAVEMENTS WITH THROUGH-THE-THICKNESS TEMPERATURE CRACKS

Summary

Formation of temperature cracks in asphalt pavements is primarily determined by properties of bitumen used for asphalt mix production. In Ukraine cracks in asphalt pavements are traditionally repaired by means of their cleaning and sealing with bitumen polymer mastics.

As an example repair technique of through-the-thickness transverse cracks in Sumskaia str. in Kharkiv is highlighted. The design and technological decisions proposed consist in the opening of through-the-thickness temperature cracks, laying of crack interrupting crushed stone layer, in place of old removed asphalt concrete, and coarse porous asphalt layer. Prior to the putting of fine-aggregate asphalt wearing course on bitumen modified with SBS polymer, repaired sites above cracks were reinforced with geosynthetic grid "Armatex RS 50/50".

1. Introduction

Cracks in asphalt wearing courses develop as a result of quick increase of thermal stresses at abrupt temperature fall in winter and deflections appearing mainly in period of frost penetration or thawing of road bed in spring. Thermal cracks develop owing to significant contraction of wearing course dimensions at its cooling resulting from relatively high coefficient of asphalt concrete thermal expansion. At cooling asphalt wearing course loses ability to stretch and stresses, exceeding tensile strength, arise in it thereby initiating cracks development. Thermal cracks are characterized by opening width, which increases with time. Formation of thermal cracks in asphalt wearing course is primarily determined by properties of bitumen used for asphalt concrete mixes production.

In order to prevent newly laid asphalt wearing courses from thermal cracks formation manufacturing engineers try to impart increased ductility and elasticity to bitumen at low temperatures as well as decrease temperature susceptibility of strength properties of asphalt concrete.

Negative influence of thermal cracks on bearing capacity of the whole pavement lies in the fact that cracks, being initial fracture spots of road pavement, open access for atmospheric moisture to underlying pavement layers.

2. Results

Field inspection of highways asphalt wearing courses revealed significant strength decrease of the whole pavement in areas of through-the-thickness cracks of monolithic pavement layers. Pavement elasticity modulus in zone of crack falls to 20-35 % on plane road sites and decreases to 40-45 % in places of longitudinal gradient change. As a result observed service life of asphalt wearing courses, which depends on the material, road category and regional climatic conditions, shortens by 5-6 years.

Typical crack opening in asphalt wearing courses is repaired by cleaning and sealing with bitumen mastics. When repairing asphalt wearing courses of urban streets and avenues preference is given to polymer modified bituminous mastics produced on thermoplastic elastomers.

Design and technique of elimination of transverse thermal cracks with broken edges, which are often met in asphalt wearing courses of urban streets and roads, are traditionally accepted based on results of preliminary inspection of wearing and underlying courses condition. Individual design should be accepted for each specific case in order to provide maximum durability of repaired wearing course. On occasion additional factors having significant influence on design acceptance are consumer's limited financial capability and technical recourses of local contractors.

Inspection of asphalt wearing course and underlying construction layers as well as development of design and technological decisions regarding elimination of through-the-thickness transverse thermal cracks in asphalt pavement layers in Sumskaia str. in Kharkiv, carried out by the Chair of Highways Construction and Maintenance from Kharkiv National Automobile and Highway University, can be cited as an example.

Results of visual inspection for determination of prevailing defects and failures of asphalt wearing course 1 km long in Sumskaia str. has shown dominant presence of transverse thermal cracks in the wearing course (Fig. 1). For the most part edges of transverse thermal cracks in asphalt surface course are deteriorated and opened to 2(3) – 15 cm. Sixty nine thermal cracks cross full width of the roadway. Thirty four cracks start at the curb and practically reach centerline of the street. Thirteen cracks cross the centerline but do not reach curb. Rehabilitation of asphalt wearing courses during service period was carried out by

means of asphalt concrete layers buildup. Recently injecting repair technology of wide transverse thermal cracks with broken edges has been applied. It was implemented by means of special machine manufactured by “Savalko” using slurry seal mixture.



Fig. 1 – General view of prevailing transverse thermal cracks with broken edges in asphalt wearing courses (Sumaskaia str., Kharkiv)

Coring of the pavement in areas without cracks in wearing course (Fig. 2) and with thermal cracks (Fig. 2) has shown that pavement consists of asphalt concrete layers 20 to 22 cm thick laid on the mineral material layer constituting mixture of broken bricks and ground concrete 25 to 40 cm thick. The material of base course was used during rebuilding period of roads and streets in Kharkiv after World War II.



Fig. 2 – General view of the core taken in the pavement area without cracks in wearing course

Survey results of cores taken from pavement has indicated that cracks with broken edges spread through total thickness of asphalt concrete layers, i. e. are through-the-thickness cracks (Fig. 3).

It is apparent that traditional technique of asphalt wearing course rebuilding, which was applied earlier on the site, and included elimination of pits, subsequent application of

bitumen tack coating on old asphalt wearing course surface and laying of new asphalt concrete layer on it, cannot be effective. Experience of highways service shows that usage of such repair technology of road wearing courses with through-the-thickness cracks results in development of reflected cracks in new monolithic asphalt layer already in one or two years. After three years of service reflected cracks open and can be visually observed. Formation of reflected cracks leads to water saturation of base courses and subsequent decrease of bearing capacity of the whole pavement construction.



Fig. 3 – General view of the core taken from pavement with crack

Taking into account traffic volume, which ranged from 12000 to 20000 vehicles per day on some sites of the street, and traffic composition, variants engineering of rebuilding technology was accomplished. Considering consumer’s limited financial resources, one of developed variants of rebuilding technology was accepted.

Suggested and accepted construction and technical decision lied in cutting of through-the-thickness cracks by means of disc cutter to the width of 50 to 60 cm and 15 to 16 cm deep. Crack cutting width depends on dimensions of manual reversing vibroplatform used for compaction. Scheme of transverse through-the-thickness cracks cutting is given in Fig. 4.

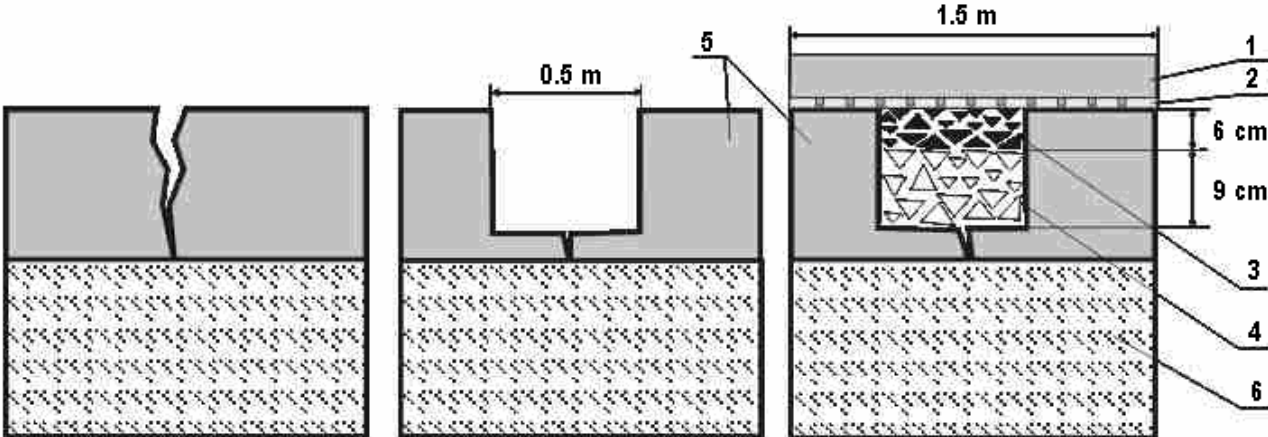


Fig. 4 – Schematic of through-the-thickness thermal crack cutting: 1 – new asphalt wearing course; 2 – geosynthetic reinforcing grid; 3 – coarse asphalt concrete; 4 – granite crushed stone; 5 – old asphalt concrete layers; 6 – base course

Proposed technology and scheme of through-the-thickness crack cutting allowed laying of crack stopping layer of crushed stone ranging from 5 to 20 mm 8-9 cm thick (Fig. 5) and a layer of coarse-aggregate porous asphalt concrete 6-8 cm thick (Fig. 6) instead of removed old asphalt concrete layers. Prior to laying of surface layer from fine-aggregate asphalt concrete mix (type “B” based on bitumen modified with 3 % of SBS polymer) on total width of the street runway, reinforcement of repaired areas over cracks with geosynthetic grid “Armatex RS 50/50” 1.5 m wide was performed (Fig. 7).



Fig. 5 – Cutting of through-the-thickness thermal cracks and crushed stone layer application



Fig. 6 – General view of site with coarse-aggregate asphalt concrete mix applied on crushed stone layer over the crack



Fig. 7 – Reinforcement of wearing course over the crack repaired with geosynthetic grid “Armatex RS 50/50”

Two year monitoring of wearing course repaired by means of suggested technology has shown that reflected transverse cracks on it in areas of repaired through-the-thickness cracks did not appear as opposed to the site where traditional technology of asphalt wearing course repair by layers buildup was implemented.

3. Conclusions

Results of elasticity modulus evaluation of pavement constructions on the network of roads of common use have shown that pavement elasticity modulus reduction in zone of crack can range from 20 to 45 %. Inspection of highway wearing courses indicate that at 12 to 15 years of regulatory service time of rehabilitated road pavement construction reflected thermal cracks on the surface of asphalt wearing course appear already in 1-2 years of service. Rebuilding of asphalt wearing course with through-the-thickness thermal cracks by means of asphalt concrete layers buildup is not effective. The application of geosynthetic reinforcing grids as well as stone mastic asphalt concretes based on SBS modified bitumen is efficient in order to control the process of reflected crack development in new asphalt wearing course. Through-the-thickness thermal cracks in asphalt wearing courses of significant thickness are efficient to cut and fill with crack stopping material prior to laying of new asphalt concrete wearing course.